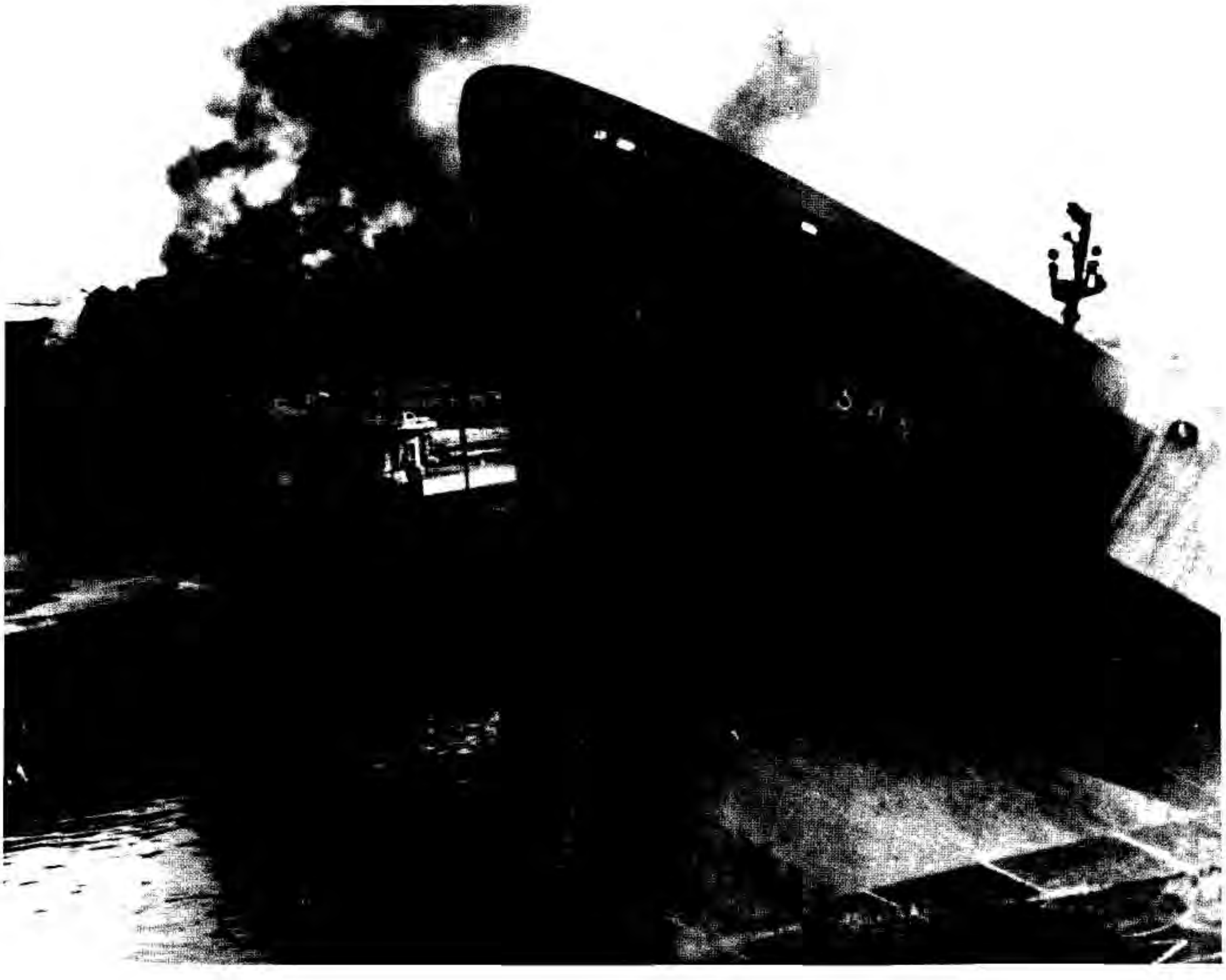
Proceedings

of the Marine Safety Council

Vol. 38, No. 8
November 1981



U.S. Department of Transportation
U.S. Coast Guard

CG-129

Proceedings

of the Marine Safety Council

Published monthly by the Commandant, USCG, in the interest of safety at sea under the auspices of the Marine Safety Council. Special permission for republication, either in whole or in part, with the exception of copyrighted articles or artwork, is not required provided credit is given to the Proceedings of the Marine Safety Council. The views expressed are those of the authors and do not represent official Coast Guard policy. All inquiries and requests for subscriptions should be addressed to Commandant (G-CMC), U.S. Coast Guard, Washington, DC 20593; (202) 426-1477. Please include mailing label when sending in a change of address. The Office of the Secretary of Transportation has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this agency. Use of funds for printing this publication has been approved by the Director of the Office of Management and Budget through May 31, 1984.

DIST. (SDL No. 114)
A: acde(2); fghklmntuv(1)
B: n(50); c(16); e(5); f(4); gj(3); r(2); bkiq(1)
C: eglmp(1)
D: adgklm(1)
E: mn(1)
F: abcdehjkloqst(1)
List TCG-06

When you have finished reading this issue, please pass it on.

Contents

features

departments

cover

The oil tanker SS SANSINENA exploded in Los Angeles Harbor in December 1976 when vapor from the cargo escaped through holes in the vent piping and collected on the afterdeck. Six lives were lost. Many similar tragedies have occurred because too few people are aware of the dangers of transporting crude oil. "Tanker Safety Depends on You" begins on page 211.

A Letter from the Editor

In the past, the Keynotes section of the Proceedings has consisted largely of reports on rulemaking projects dating back as far as 1974. In many instances, the status of these projects changes little from month to month. We have therefore concluded that it is a waste of the magazine's space and your time to repeat the reports in each issue. We will soon be introducing a new format for the Keynotes section. Instead of reprinting the old descriptions of only those regulations deemed "significant," we will provide expanded descriptions of those items published recently in the Federal Register which we think will be of interest to you. Any action taken on the older projects will also be reported.

You will notice a new department in this month's issue: "What's What in the Maritime Industry." The American Institute of Merchant Shipping has been kind enough to provide the first article for this section. I would like to take this opportunity to extend a standing invitation to all the professional societies, trade associations, or other organizations operating in the maritime industry to write and tell us what their purposes are and what activities they are engaged in.

Articles from other readers are always welcome, too, of course. I also enjoy your letters and thank those of you who take the time to write.

Julie Strickler

Julie Strickler

Coast Guard Requests Information and Comments on Maneuvering Performance Standards

The ability of a vessel to maneuver is important to safe navigation. There are presently no national or international maneuvering performance standards. If standards were developed, they could be used by:

- ship owners and operators for guidance when purchasing or chartering a vessel,
- ship designers to ensure that inherent controllability is considered in a systematic manner, and
- pilots and masters to describe each ship maneuvering performance when assessing the safety procedures required.

Also lacking are 1) a standardized agenda for maneuvering trials for shipbuilders and 2) vessel maneuvering information that maritime law enforcement officials could use for assessing port entry and operating conditions, especially in cases where pollution or hazardous situations might result.

Recognizing this, the Coast Guard has initiated a project to:

- determine inherent maneuvering performance characteristics of existing vessels,
- single out those characteristics which best describe maneuvering performance, and
- establish a performance rating system for maneuvering characteristics.

Tentative ratings might be assigned to new vessels on the basis of vessel design and, in some cases, model basin testing. Final performance ratings would then be established through maneuvering trials performed in conjunction with the builder's sea trials. This approach to developing maneuvering performance standards is described in an advance notice of proposed rulemaking published in the Federal Register on September 14, 1981.

One possibility suggested in the advance notice would work as follows: vessels would be assigned categories such as outstanding (A and B), average (C and D), and poor (E) on the basis of their inherent maneuvering performance. To develop these ratings, the Coast Guard would compare the maneuvering characteristics of those vessels known by pilots and masters for their "good" performance to the characteristics of the majority of vessels. Owners would be encouraged to perform supplementary trials once the vessels were in service to provide additional information.

The Coast Guard needs input from the marine industry and the public to develop these performance standards. Reprints of the advance notice may be obtained by writing: Commandant (G-MMT-4/13), U.S. Coast Guard, Washington, DC 20593. Comments and data should be submitted under Docket No. CGD 80-136 to: Commandant (G-CMC), U.S. Coast Guard, Washington, DC 20593.

"Close Encounters" Wins Award

The Coast Guard's slide/tape show entitled "Close Encounters of a Dangerous Kind" recently received top honors from the National Association for Government Communicators (NACG). At the NACG's "Gold Screen Competition" awards luncheon, "Close Encounters" took first place in the category of best Information/Educational program. The NACG is a nonprofit organization which seeks to recognize outstanding work produced by government communicators in the audiovisual field.

"Close Encounters" appeared in adapted form as the cover story of the last issue of the Proceedings (September/October 1981). The story (and the show) used quotes from mariners and photographs of the incidents they described to illustrate the potential disasters resulting from conflicts between recreational and commercial use of the U.S. ports and inland waterways.

Lieutenant Commander William Ladd, Chief of the the Boating Education Branch, accepted the award for the Coast Guard.

IOTC Principles Signed

On July 29, 1981, RADM R. A. Baumann, Chief of the Coast Guard's Office of Navigation, signed the International OMEGA Technical Commision (IOTC) Principles. These principles were drafted by the seven members of OMEGA—Norway, Liberia, the United States, France, Argentina, Australia, and Japan—in the interest of better coordinating operation of the OMEGA Radionavigation System. The Commission will act as a forum for consultation regarding operation and maintenance of OMEGA. Its broad objectives will be:

1) to achieve effective harmonization among the operating agencies of the member countries, OMEGA users, equipment manufacturers, and international and scientific organizations/associations and
2) to promote the continued operation and improvement of OMEGA for the safe and expeditious movement of vessels and aircraft.

Specifically, it will be charged with:

1) promoting the international coordination of OMEGA matters,
2) facilitating the exchange of technical information between and among the operating agencies as well as OMEGA users,
3) fostering public understanding and user education by providing information through national and international forums,
4) considering comments from users and others, and
5) making recommendations regarding the operation and administration of OMEGA.

The Principles will be implemented when all the member countries have signed. As this issue was going to press, Norway, Liberia, and the U.S. had signed, and the Principles had been sent on to France.

Correction

Reader Edward J. Geissler of the Maine Maritime Academy has correctly pointed out that there is an inconsistency between Rules 11 and 13 (Part B, Subpart II) in the May installment of our series on the new Inland Navigation Rules (pp. 64 - 65). The second sentence of Rule 13, "It extends the applicability of the overtaking rules to all conditions of visibility," should be deleted.

New Safety Publication for Fishermen Started

Richard C. Hiscock, a consultant on fishing vessel safety and emergency rescue/survival equipment, has started a new publication called "Safety Notes for Fishermen." The first issue came out in October and was subtitled "You Are Not a Survivor Until You Are Rescued." Someone forced to abandon his vessel must make his position known to rescue authorities promptly and accurately and survive until help arrives. In a discussion of EPIRBs, survival suits, and life rafts, issue No. 1 tells how to do this.

Mr. Hiscock is presently offering his publication free of charge. Interested parties should write to him at 545 Old Harbor Road, North Chatham, Massachusetts 02650 or call him at (617) 945-9098.

New Exercises Being Prepared for New Inland Rules

On December 24, 1981, the new Inland Navigation Rules will become effective. Navigation and Vessel Inspection Circulars with appropriate Rules of the Road exercises for Deck Officers', Operators', and Motorboat Operators' license renewals are forthcoming and will be announced in the next issue of the Proceedings.

Office of R & D Releases Reports

The Coast Guard's Office of Research and Development has released the preliminary field evaluation of three very different marine vessels. The full title of the report is "A Vessel Class Comparison of Physiological, Affective State, and Psychomotor Performance Changes in Men at Sea." The study was done to compare the influence of marine vessel motions characteristic of three marine vessels on the incidence of motion sickness, stress, and psychomotor performance in male Coast Guard personnel.

The vessels being studied were an experimental Navy 89-foot small waterplane area twin hull (SWATH) vessel, a 95-foot Coast Guard patrol boat, and a 378-foot Coast Guard high-endurance cutter. It was found that when personnel suffered severe motion sickness on the 95-foot patrol boat, none was experienced under similar sea state conditions on board either the SWATH vessel or the high-endurance cutter. Limited recommendations are offered with regard to design criteria for vessel ride quality.

Copies of this report can be obtained from the National Technical Information Service (NTIS), Springfield, Virginia 22161, by specifying Report No. CG-D-07-81, Accession No. AD-A098-047.

Also available from NTIS is an R & D report on "springing," the vertical vibration to which the long, narrow, shallow vessels designed for the locks in the Great Lakes are susceptible. The report describes measurements of this behavior taken on board the STEWART J. CORT, a 1,000-foot Great Lakes ore carrier, by the Naval Ship Research and Devlopment Center in conjunction with the Coast Guard. Waves, pressures, hull stresses, and accelerations were measured. The data were then analyzed, and comparisons were made between measured and analytical data. The main text of this report includes a complete description of the instrumentation, calibration, data analysis, and results. The information should be of particular interest to naval architects and others involved in ship design and should contribute to a better understanding of springing and improved structural standards.

Copies of this report can be obtained from the NTIS by specifying Report No. CG-D-17-81, Accession No. AD-A100-293. ⚓

The following items were published between August 25, 1981, and September 21, 1981:

Final rules: CGD 79-120 Regulated Navigation Area; Chesapeake Bay Entrance, August 31, 1981. CGD 81-056 Drawbridge Operation Regulations; Moser Channel, Monroe County, Florida, September 8, 1981.

Notices of proposed rulemaking (NPRMs): CGD 14-81-01 Drawbridge Operation Regulations; Honolulu Harbor, Hawaii, August 31, 1981. CGD 81-055 Drawbridge Operation Regulations; St. Joseph River, Michigan, August 31, 1981. CGD 7-81-04 Safety Zone; Vicinity of Bascule Bridge, Ft. Lauderdale, Florida, August 31, 1981. CGD 5-81-6R Anchorage Regulations; Elizabeth River, Norfolk, Virginia, September 8, 1981. CGD 3-81-1A Anchorage Grounds, Port of New York and Vicinity, September 8, 1981.

Advance notice of proposed rulemaking (ANPRM): CGD 80-136 Maneuvering Performance Standards for U.S.-flag Vessels, September 14, 1981. (For more information on this project, see the article in the Maritime Sidelights section)

Notices: CGD 81-069 Chemical Transportation Advisory Committee; Subcommittee on Chemical Vessels; Notice of Meeting, August 31, 1981. CGD 81-070 Chemical Transportation Advisory Committee, Notice of Meeting, August 31, 1981. CGD 81-065 Coast Guard User Fees, Notice of Informal Meeting, September 3, 1981. CGD 81-072 New York Vessel Traffic Service Advisory Committee, Notice of Meeting, September 17, 1981.

Any questions regarding regulatory dockets should be directed to Commander A. D. Utara (G-CMC), U.S. Coast Guard Headquarters, 2100 Second St. SW, Washington, DC 20593; (202) 426-1477.

* * *

Actions of the Marine Safety Council

September Meeting

New Project

CGD 81-067 Ice Season Regulated Navigation Area, COTP Baltimore Zone

For the past several years the domestic icebreaking program has used the authority of the Marine Safety Office in controlling vessel traffic. The procedure consisted of issuing Captain of the Port (COTP) orders which would place horsepower or size limitations on vessels wishing to travel along various routes. The program was only partially successful, since some vessel operators claimed they were not aware of the limitations, even though the information was disseminated through broadcast of Notices to Mariners and a telephone recording at the Marine Safety Office in Baltimore.

To correct this deficiency and reduce dangers for all vessels concerned, an "Ice Season Regulated Navigation Area" will be instituted for all or part of the COTP Baltimore zone. The specific requirement to be incorporated in the regulation would be for operators to make themselves aware of and to comply with the COTP orders. An NPRM should be published in October, and a final rule is targeted for December.

Withdrawals

In accordance with the President's Regulatory Relief Program, the Coast Guard is systematically reviewing active regulatory projects. This review has resulted in requests for withdrawal of eight projects. The Marine Safety Council approved all requests. If an ANPRM or NPRM was previously published in the Federal Register, official notification of the withdrawal will also be published. The eight projects are:

CGD 75-001 Elevators and Dumbwaiters

An NPRM was published on April 5, 1976. The American National Standards Institute (ANSI) is currently developing a standard which is comparable in intent to the proposed regulations. Accordingly, no further Coast Guard action is needed.

CGD 77-204 Second Class Operator for Towing Vessels

An NPRM was published on May 25, 1978. The portions of this package which have legislative authority and are still considered necessary will be addressed in another project.

CGD 79-038 Steering Gear, Drills and Tests

This will be combined with the proposal to revise Title 33 of the Code of Federal Regulations, Part 164 (33 CFR 164), Navigation Safety Regulations.

CGD 79-095 Shipment of Bulk Hazardous Waste by Water

An NPRM was published on October 14, 1980. An evaluation of the comments received has shown insufficient evidence to justify additional regulations at this time.

CGD 79-159 Tank Stop Valves

An ANPRM was published on April 16, 1981. The comments received showed that regulations would be too costly.

CGD 79-173 License in Temporary Grades

An NPRM was published on August 18, 1980. An evaluation of the comments received has shown insufficient evidence to justify additional regulations as this time.

CGD 80-065 Carriage of Liquefied Gases

Several of the requirements would apply to only one vessel and cannot be justified. The remaining requirements will be combined with another regulatory package under development.

CGD 80-108 Qualifying Corporations as U.S. Citizens for Documentation Purposes

Since another project involves review of all documentation regulations, a separate regulatory package is not necessary.

Representative Lawrence Coughlin (R-Pennsylvania) recently asked Vice Admiral R. H. Scarborough for an explanation of the merchant vessel documentation system, which is often confusing because of its oaths, documents, and special forms. The Admiral's reply is reprinted here because it sheds some light on the mysteries of the old system and shows the direction of a new system that is being prepared for the documentation system.

"Dear Mr. Coughlin,

"You may recall that during our conversation at a recent social affair, you expressed concern for our rather antiquated vessel documentation procedures. Of particular concern were the burdensome requirements for the annual renewal. I have since looked into the matter and find that there is some hope on the horizon!

"The Vessel Documentation Act (Public Law 96-594) will have considerable impact on the Coast Guard vessel documentation program. The Act, which becomes effective on July 1, 1982, will permit simplification in many areas. Since the regulatory project is ongoing, I cannnot provide all of the specifics; however, the improvements discussed below will give you a good idea of our intent to simplify vessel documentation procedures to the maximum extent.

"There are presently six forms of marine documents issued to vessels: a register, for vessels engaged in foreign trade; a license, for vessels under twenty tons engaged in the coastwise trade and/or the American fisheries; a consolidated certificate of enrollment and license, for vessels of five or more net tons in the Great Lakes engaged in trade with Canada and/or the coastwise trade and/or the American fisheries; and two forms of yacht documents. Under the Act, there will be but one marine document, a Certificate of Documentation. The Certificate will be appropriately endorsed for the employment or employments of the vessel.

"The present annual renewal of a vessel license requires the master to complete an application in oath form and to present the oath with the license to a Coast Guard vessel documentation officer. Under the new system, neither an oath nor presentation of the license will be required.

"Under the present system, a bill of sale is required to recite in full the last marine document of the vessel. Since, as indicated in the preceding paragraph, there are different forms of marine documents, the bills of sale differ in format. The Vessel Documentation Act will eliminate the requirement for recitation of the last marine document. We will, therefore, be able to go from four different bill of sale forms, each four pages, to a single one-page bill of sale form.

"At present, on initial documentation of a vessel, there are required a designation of home port, an application for official number, and a lengthy form setting forth the oaths required for documentation. These will be replaced by one simplified multipurpose form.

"There are now a number of specific vessel documentation requirements for presentation of evidence relating to establishing the legal status and/or citizenship of vessel owners. These requirements will be eliminated. The multipurpose form mentioned in the preceding paragraph will suffice.

"Presently, whenever a documented vessel undergoes a change of ownership, trade change, or other similar change, the marine document of the vessel must be surrendered and a new one issued. Under the Act, most changes will be accommodated by an endorsement on the Certificate of Documentation.

"These are some of the many improvements that will be carried out under the Vessel Documentation Act. On the other hand, there are many laws not affected by the Act which will continue to require extensive presentation and checking of evidence. These include the maintenance of records and recording of instruments under the Ship Mortgage Act, 1920, as amended; restrictions on employment of foreign-built vessels; restrictions based on sale of a vessel in whole or in part to an alien; restrictions based on placing a vessel under foreign registry; restrictions based on rebuilding a vessel abroad; restrictions on foreign installation of segregated ballast tanks, crude oil washing systems, or inert gas systems; and restrictions based on citizenship of vessel owners.

"I hope this summary of some of the areas of improvement is helpful. I expect that the regulations will be ready for publication as proposed rulemaking in November 1981. If you need further information, please let me know."

Sincerely,

R. H. Scarborough
Vice Admiral, U.S. Coast Guard

The American Institute of Merchant Shipping

by AIMS President
Rear Admiral W. M. Benkert, USCG (Ret.)

The American Institute of Merchant Shipping (AIMS) is a nonprofit trade association based in Washington, DC. Its 29 member companies own or operate 236 deep-draft U.S.-flag vessels with a combined total of almost twelve million deadweight tons, about half the tonnage of the U.S.-flag oceangoing vessels.

AIMS was founded to represent the interests of its members in matters affecting the ownership and operation of U.S.-flag merchant ships. AIMS is concerned with, among other things, maintaining the highest standards of ship management, ensuring operating safety, and protecting the marine environment.

Although AIMS has a small staff—twelve professional and support staff members in all—it is engaged in a wide range of international, national, state, and local activities.

At the international level, AIMS provides extensive input for the technical work done by the Inter-Governmental Maritime Consultative Organization (IMCO), an arm of the United Nations comprising 121 countries concerned with maritime matters. In preparation for IMCO meetings on technical issues, AIMS often works closely with Coast Guard-chaired working groups under the auspices of the U.S. Shipping Coordinating Committee. It frequently attends the international meetings in an advisory capacity, as well. As a representative of U.S.-flag merchant shipping, AIMS also works with the International Chamber of Shipping (ICS) and the International Shipping Federation (ISF) on technical and personnel matters involving vessels.

Nationally, AIMS maintains an active liaison with Congress and Federal departments and agencies to monitor activities and to convey the views of its members. This regular interaction and monitoring of legislative and regulatory affairs represents a substantial portion of the organization's daily operations.

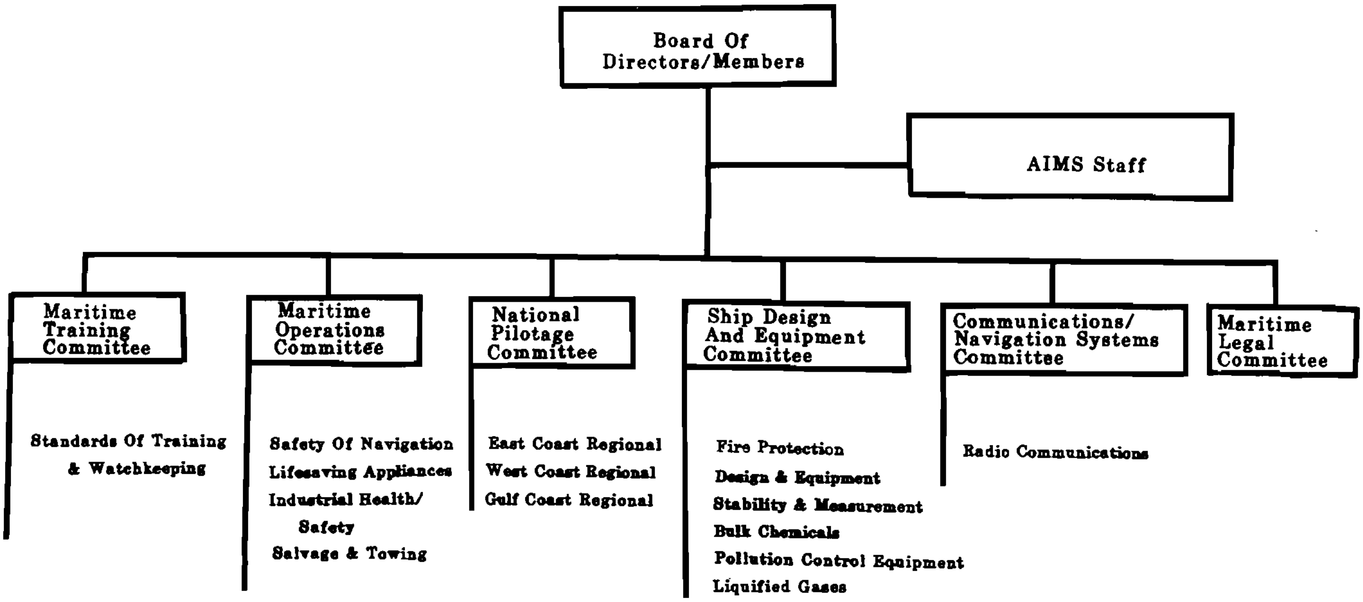
AIMS' involvement at the state and local levels has assumed ever greater importance because of expanding public interest in safety and environmental issues. In this regard, AIMS seeks to convince the general public that the best way to ensure safe vessel operations and protect the environment is through strong, uniform international standards complemented where necessary with appropriate national implementing legislation and/or regulation.

Within the past year, AIMS has restructured its internal committees in an effort to better integrate its domestic and international activities. In its present form, the committee system largely parallels the structure of the Federal Government's Shipping Coordinating Committee. The areas of responsibility of the six parent committees—Maritime Training, Maritime Operations, National Pilotage, Ship Design and Equipment, Communications/Navigation Systems, and Maritime Legal—are shown in the diagram on the following page. Under these parent committees, a dozen subcommittees of four to six members each facilitate AIMS' technical work by providing vital expertise. AIMS feels that this system will ensure more direct and deeper involvement on the part of an increased number of member company representatives.

A strong advocate of marine safety, AIMS does not limit its support of this cause to its technical efforts. Each year it sponsors three safety-related contests which are designed not only to recognize the achievements of individuals or crews but also to help focus public attention on the importance of having a U.S.-flag fleet which is strong, secure, and above all, safe. The following are brief descriptions of these three contests:

American-flag ships which operate for a specific duration without a lost-time personnel accident automatically receive the **Jones F. Devlin Award.** This award is given in different categories, depending on how many accident-free years a vessel has had. The contest gets underway in January, when flyers announcing contest rules and soliciting entries are mailed to the safety directors of U.S.-flag steamship companies. Devlin Award winners are honored each year at a Safety Awards Luncheon held in New York City which is attended by maritime industry leaders and top flag officers of the Coast Guard.

The **Ship Safety Achievement Awards** are jointly sponsored by AIMS and the Marine Section of the National Safety Council. The recipients of these



awards are American-flag vessels which have performed outstanding feats of rescue or seamanship reflecting the high safety standards prevailing in the U.S. fleet. Such feats may include, but are not limited to: rescue, assistance to distressed vessels, transfer of ill or injured persons under difficult sea conditions, and outstanding demonstrations of seamanship and ship operation which contributed to saving a life or a ship. A press release and flyers are mailed out along with notice of the Devlin Awards contest in January. In the spring, a judging committee consisting of persons prominent in the marine safety field studies accounts of the various rescue acts and selects the winners. The awards are not announced until the time of presentation. Presentation ceremonies are often scheduled on board the winning vessels.

To date, only one Ship Safety Achievement Award has been conferred for 1980. This award went to the officers and crew of Interocean Management Corporation's SS GREAT LAND for extinguishing a serious fire on board the vessel with great speed and efficiency.

More award presentations are scheduled for later in the fall.

The **Halert C. Shepheard Award,** named in honor of the late Rear Admiral Halert C. Shepheard (USCG), is sponsored by AIMS and administered by the American Bureau of Shipping. RADM Shepheard was a tireless champion of merchant marine safety, and this award—a Steuben crystal eagle—is presented to an individual in recognition of his contribution to the field. Entries for this award contest are solicited by the American Bureau of Shipping in early fall. The contest deadline is January 1, and the award is presented in the spring.

In summary, AIMS, through its professional involvement in a range of technical matters, government relations, and public affairs, works continuously to ensure that the U.S. can rely on a sound merchant marine which will meet the nation's needs in times of both war and peace. This article has touched upon only a few of the areas in which AIMS is involved. Readers wishing to know more about AIMS and its role in the U.S. Merchant Marine are invited to contact the organization at 1625 K Street NW, Washington, DC 20006; (202) 783-6440. ⚓

About the Author

Rear Admiral William M. Benkert, USCG (Ret.), a Coast Guard Academy graduate, commanded several vessels during combat duty in the Pacific (World War II) and Korea. His later sea duty assignments included command of five Coast Guard vessels engaged in search and rescue work, aids to navigation, ocean station weather patrol, and polar icebreaking. While ashore, he commanded marine inspection offices and was extensively involved in marine safety. At Coast Guard Headquarters, RADM Benkert served as Assistant Chief of the Merchant Vessel Inspection Division, Chief of the Office of Marine Environment and Systems, and Chief of the Office of Merchant Marine Safety.

Internationally, he has participated in and headed the U.S. delegation to IMCO conferences on such subjects as safety, pollution prevention, and personnel standards.

RADM Benkert is active in the Society of Naval Architects and Marine Engineers and a number of other professional maritime organizations. He also serves on the National Academy of Sciences Maritime Transportation Research Board and in other Government and industry advisory organizations.

How a Hull Takes Stress

(Reprinted with permission from Exxon Marine, copyright 1980 by Exxon Corporation)

During the past few decades tankers have grown tremendously in size. This fact is well known. But it is less well known that, because of improvements in structural design, tankers are generally better able to withstand stresses from both waves and their own cargo.

A decade ago shipyards around the world were busy building ships that were larger than any that had ever before set sail. To many uninformed people, the rapid increase in ship size during a short period of time suggested careless construction. But in fact, the economic need for more efficient ships coincided with the development of more sophisticated ship design and construction techniques. The result is that modern supertankers approach the ideal of the naval architect—steel is used solely where it adds strength, not where it only adds to the ship's weight.

Beginning in the late 1950s and early 1960s, an enormous amount of work was done at shipyards, classification societies, large shipping companies, and universities and model testing tanks to reach this ideal. The result? By the late 1960s the same amount of steel was used to construct 200,000 dwt tankers that had been used in the construction of the MANHATTAN --a 100,000 dwt ship built in 1962.

Various factors made this increased efficiency possible. The computer—by now a refined tool in many disciplines—was the essential bridge between practical rules of thumb and sophisticated theoretical applications. The computer allowed the naval architect and the shipbuilder to assess alternatives without sending ships to sea to check out each shipbuilding theory. Then, too, improved structural and civil engineering theories similar to those used in building complex bridges and jumbo jets could finally be applied to shipbuilding. And better welding sequences and joining processes were also adopted. Finally, knowledge about connecting individual structural elements had become more sophisticated.

Theory and practical experience

Designing a ship has always been a blend of theory and practical experience. But practical experience has predominated in ship design perhaps more than in other engineering fields because the forces a ship faces at sea are varied and difficult to predict. In addition, a tanker faces not only the forces of the sea but also the stresses of carrying a cargo which may weigh up to ten times the weight of the tanker itself.

Developing structural theory to quantify these various forces has been a slowly evolving process, not only because of the difficulty of predicting the effect of the sea on ships' hulls, but also because even a small ship's hull is a very complex mixture of structural elements. It is made up of beams, columns, and thin plates and is subjected alternately to tensile (pull), compressive (squeeze), and torsional (twisting) forces and buckling. The hull challenged theoreticians.

In the days when riveted construction was the rule, a high percentage of the steel in a tanker's hull went into the outer shell plating, and less attention was paid to the interaction between plating and framing structural members. Now, although plating is thinner, more robust and effective framing and stiffening members are used, and far greater attention is paid to designing frames and plating as an integrated whole.

In the mid-1950s, the first 50,000 dwt tankers were commonly built with 38-millimeter (1½-inch) deck and bottom plating; double plating was frequently used in some areas. Today, a tanker with ten times that capacity is built with 32-millimeter (about 1¼-inch) plating. Yet the newer ships have greater reserve strength against buckling.

Putting less steel in ships saves more than money and cargo capacity. Thinner plating also facilitates quality control of the steel itself and permits more uniform welding. When thick plates are welded together, it is difficult to control what goes on deep inside the weld. And, as the plates fuse

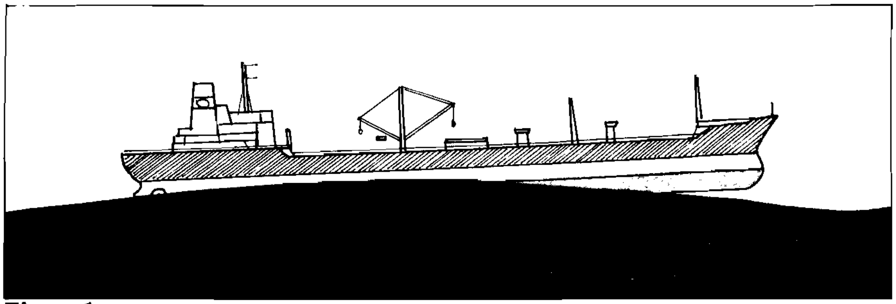


Figure 1

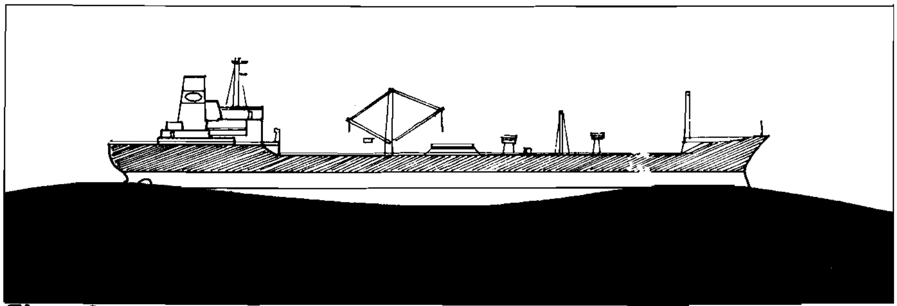


Figure 2

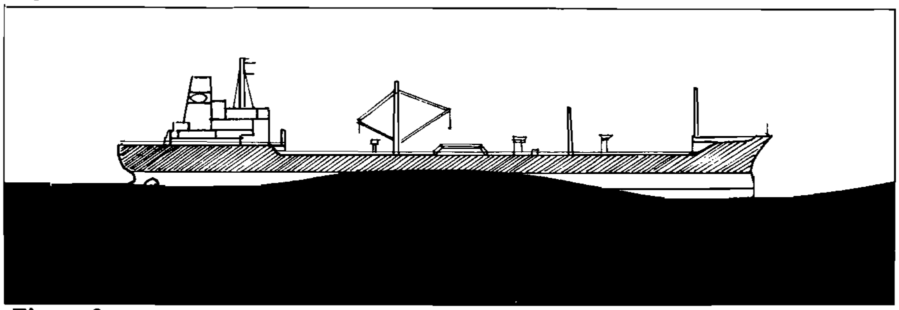


Figure 3

To understand how wave action places stress on a ship, consider first the most extreme case--when the distance between wave crests approximately equals the length of the hull. In this situation, it is possible for the bow and the stern to be lifted on adjacent wave crests, and for the midsection to be left largely unsupported in the wave trough. At this instant, the ship is said to be sagging (Figure 1). Within seconds, the ship moves into a position in which it is supported predominantly by a single wave crest amidships. Now the bow and stern are unsupported, and the ship is said to be hogging (Figure 2). This, of course, is a simplification: actual waves are irregular in shape and seldom look like these simple examples. Less predictable are the forces on the hull when the ship rides up the side of a wave and then slams down into the following trough (Figure 3). Slamming sets up vibratory forces in the structure which compound existing stresses.

together and contract as they cool, unknown stresses can be locked permanently into the structure; these stresses may be the source of problems when the ship goes to sea. As hull design has improved, thinner plating has helped reduce such "locked-in" stresses.

Wave-induced stresses

Under the influence of waves which alternately produce sagging and hogging (see Figures 1 and 2), the hull behaves like a simple beam for which shearing and bending stresses can be calculated. But the irregular nature of actual ocean waves complicates this picture. Rather than being subjected merely to alternately bending forces in the vertical plane, the ship is also subjected to bending in the horizontal plane, as well as torsion (twist) along its entire length. The combination of these forces produces stresses, principally in the outer skin and its accompanying framing, which alternate between tension and compression. Varying degrees of shearing are also imposed. And, since the wave system is always moving in relation to the ship, these forces are continually changing.

Loading stresses

Although wave loads produce large forces, they are not the only forces the hull must withstand. Bending and shearing forces are present even at dockside for an empty ship. As cargo is loaded aboard, loading stresses vary continually. When the tanker is at sea, loading stresses combine with wave-induced stresses. The hull must withstand the combined stresses.

In general, loading (still-water) stresses on a large tanker are roughly equal in magnitude to the largest wave-induced stresses. Because the wave stresses alternate in direction as each wave passes the ship's hull, they either add to or subtract from the loading stresses. Before a large modern tanker sets sail, careful calculations of loading stresses are routinely made. Each ship is supplied with a loading manual, and deck officers are able to predict loading forces for different distributions and layouts of cargo or ballast.

Most modern large ships also use special-purpose computers which display bending moments and shear at each bulkhead. Loading computers have proved to be invaluable to ships' officers in determining acceptable loading and discharging sequences, which would otherwise require lengthy manual calculations.

Structural interactions

The hull plates of a large tanker are no thicker in proportion to its overall dimensions than the paper wrapper around a loaf of bread is. The ratio of the plate to the overall dimension is approximately 1:600. The strength of steel is such that plates of this size are sufficient to handle tensile loads. But without bulkheads, frames, and other stiffeners, this thin skin could not resist bending and compressive forces and would collapse under its own weight.

The primary supports for the ship's outer skin are flat-plate bulkheads which conveniently also serve to subdivide the ship into cargo tanks. Bulkheads in turn must be supported by large primary and smaller secondary framing members, as must the deck and side, and bottom shell plating. Each of these plate panels and its associated framing must then resist loads (in the case of deck and bottom plating, the loads are the alternating tensile and compressive forces caused by waves) and normal forces perpendicular to them caused by the weight of the cargo inside the ship and the buoyancy of the sea outside. Vertical bulkheads resisting normal forces play a role identical to that of a dam keeping back water.

The problem of buckling is solved by adding stiffening members. But how far apart should the stiffening members be placed to prevent unacceptable bending of the shell in between members? And how thick must each stiffening member be? Clearly, the bending or bowing effect is greater in some parts of the plating than in others, but if the stiffening member at one point is made unduly rigid, it will take all of the load while other, lighter members will merely flex away from the load and thus do little to add overall strength.

Because there are a great many possible structural and loading arrangements, the number of design configurations for a new tanker is theoretically almost limitless. To restrict the alternatives to a reasonable number, the naval architect blends the lessons of practical experience with the conclusions of theory. High-speed electronic computers have enabled ship designers to examine a far wider array of practical alternatives, and in a reasonably short time, than was the case a few years ago.

Mostly through practical experience based on the results of past designs, the naval architect has learned to choose a discrete number of "design conditions," or combinations of loaded conditions and sea force constraints, which permit the adequacy of the design to be verified before construction is begun.

Testing for stress

Comprehensive measurements of stresses occurring within the structure of a large tanker under actual working conditions were made in 1969 by Exxon International in cooperation with the German classification society Germanischer Lloyd. The newly built 190,800 dwt ESSO NORWAY was used for the study. Measurements were made to determine stresses caused by loading in still water and

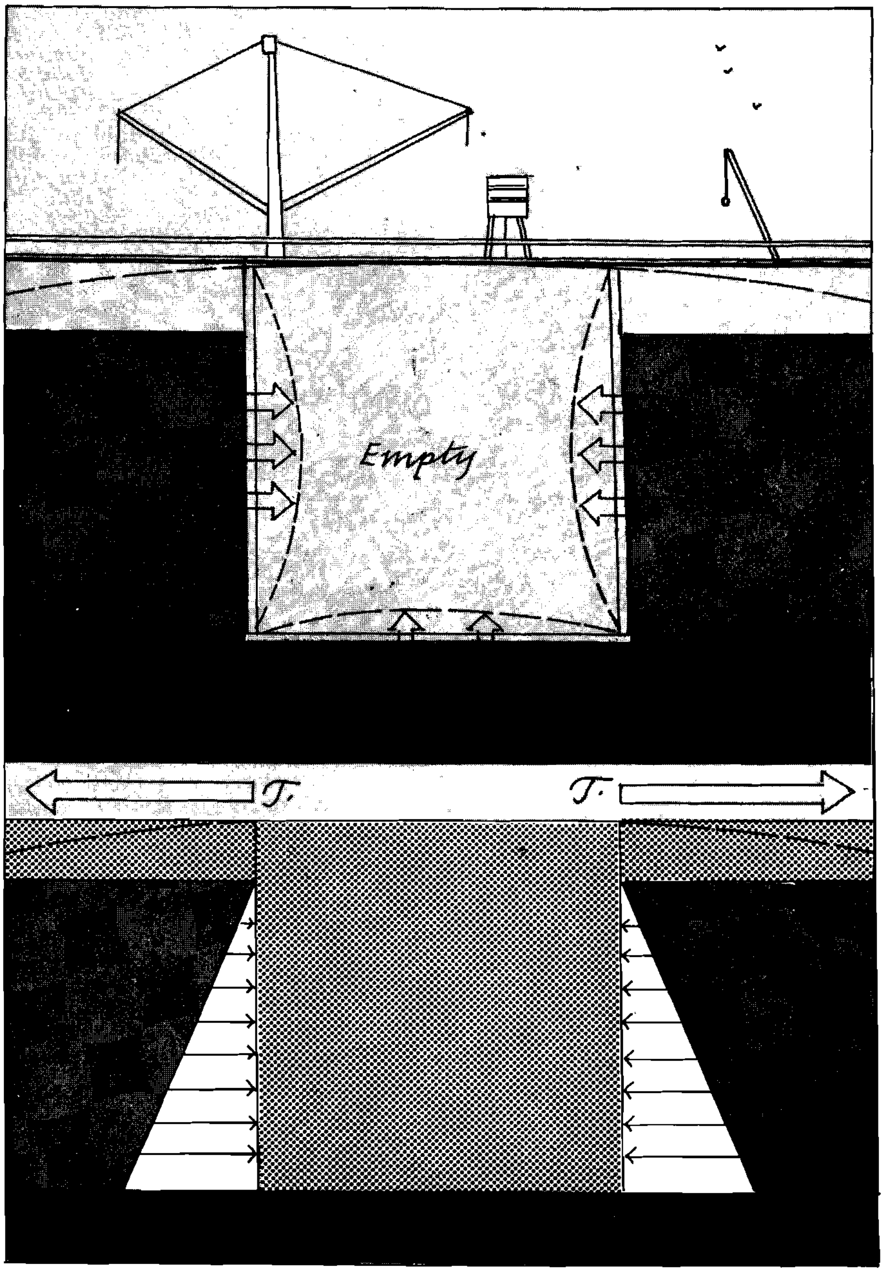


Figure 4

Imagine, for instance, that one tank is empty and the tanks on either side of it are full. The liquid in the adjacent tanks exerts pressure on the dividing bulkheads. This pressure increases at the bottom of the tanks. Water pressure on the underside of the full tanks is partly counterbalanced by the pressure of the liquid in the tanks, but water pressure on the underside of the empty tank meets no resistance. As a result, the sides and bottom of the empty tank are very slightly bowed in. Clearly, with longitudinal compressive forces, as in Figure 2, added to these panels of plating, they tend to bow and buckle further.

by the operation of the ship through waves.

In the shipyard about 1,400 strain gauges were placed on the structural members of two tanks to measure the actual deflections (strains) under load, from which stress could be calculated. In addition, piano wire gauges running from the deck to the bottom plates measured deformations in the structure as a whole.

For the first nine days, static tests were made while the ship was at anchor. For these tests, various combinations of tanks were filled with ballast, and the resulting stresses imposed on the structure of the tanks were measured. Measurements were limited to a pair of center and wing tanks amidships, and a combination of empty and full loading conditions at different drafts was carefully selected in order to impose a wide range of loading stresses on the structure. In all, 11 test runs were made with different levels of ballast in the tanks and with the vessel at different drafts. Care was taken that none of the loading conditions imposed bending and shearing stresses on the hull as a whole that exceeded the design value for the ship. A total of 28,000 stress measurements was made and recorded during these loading tests. On completion of these tests, the ESSO NORWAY set sail for its dynamic tests under actual sea conditions.

The ship's heave, pitch, and roll were measured by accelerometers and a gyroscope. Pressure gauges measured the action of waves against the ship's sides. Signals from each of these gauges were brought back to a central measuring station on the deck, where they were continuously scanned and recorded.

The test route took the ship from Kiel, Germany, around the Cape of Good Hope to the port of Ras Tanura in the Persian Gulf. During this voyage, three periods of fairly rough weather were selected as test runs. The severity of the seas ("energy spectra" to the naval architect) encountered during these test runs was calculated from the motions of the ship as detected by the accelerometer in the bow and by the pitching and rolling angles. At the same time, stresses at 45 locations throughout the hull were measured and recorded on magnetic tape.

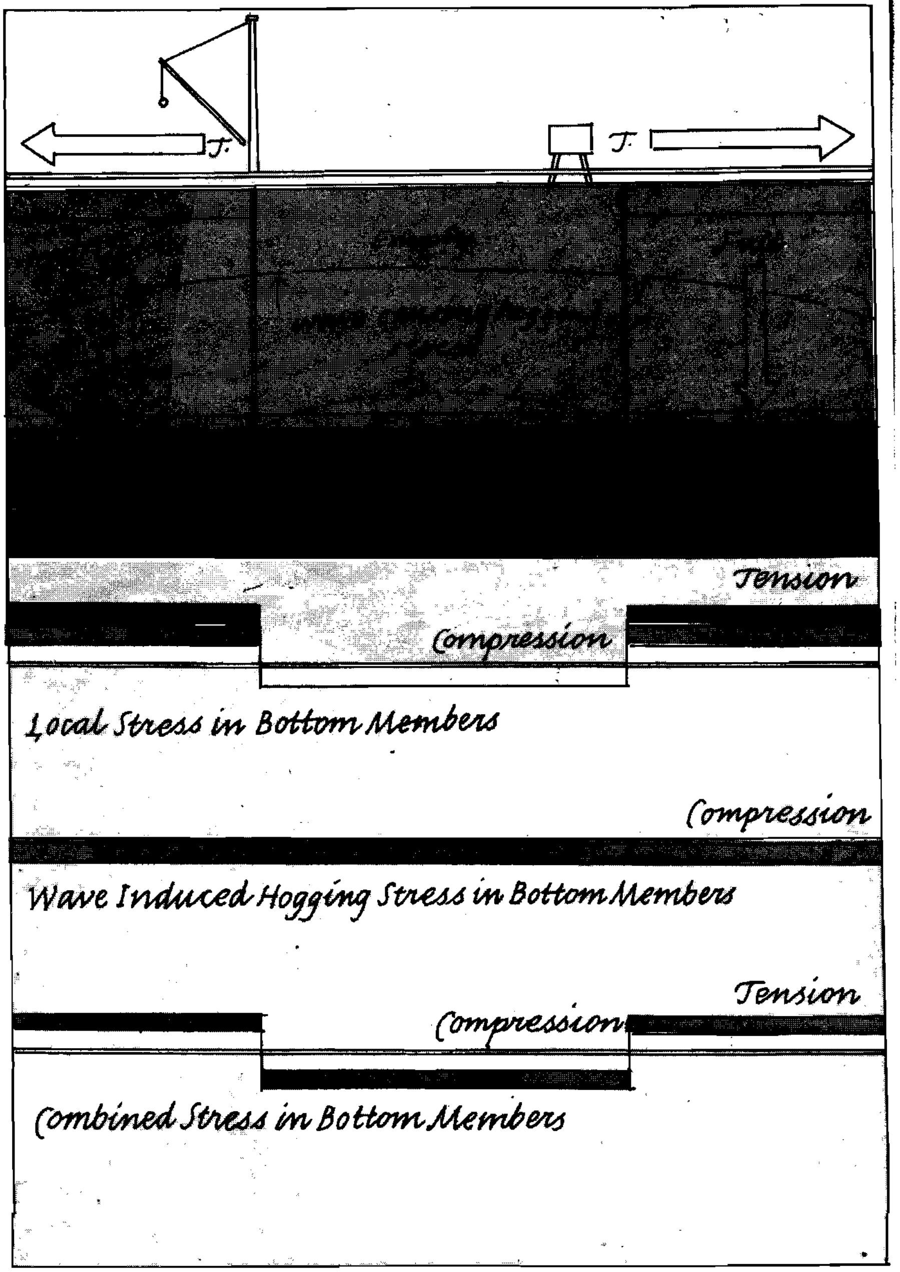


Figure 5

As bottom longitudinal structural members, under the pressure of cargo in full tanks or seawater in empty tanks, intersect with larger (and stiffer) transverse framing members, they are subjected to alternating bending moments along their length--tension at some points, compression at others. If longitudinal compressive stress due to hogging is now added to these loading stresses, stress is increased where compression already exists but is decreased where the steel member is in tension.

About the same time, the American Bureau of Shipping conducted a comprehensive test program to accumulate long-term stress and wave bending information. The six ships in that program—one of which was the ESSO MALAYSIA, sistership of the ESSO NORWAY—were instrumented with gauges so that stress levels over a long period of time could be recorded automatically. The results of that program and others of a similar nature have been extremely valuable in attempts to answer the question of how severe are the most extreme conditions to which a ship may be subjected in its lifetime.

When the ESSO NORWAY tests were complete, Exxon International decided to leave final analysis of the data to other organizations instead of presenting a completed analysis to the shipping community. The raw data were given to a number of classification societies and shipyards, as were some questions: How would you analyze these data? How do these results compare with the results your methods of predicting would produce?

The availability of this mass of full-scale ship data caused several organizations to upgrade or completely replace the computer programs that they had been using to analyze ship structure. The eventual result was a much clearer understanding of how hull structural members interact, how panel stiffness is a significant factor, and why more attention should be paid to buckling criteria and to deflections than has been done in the past.

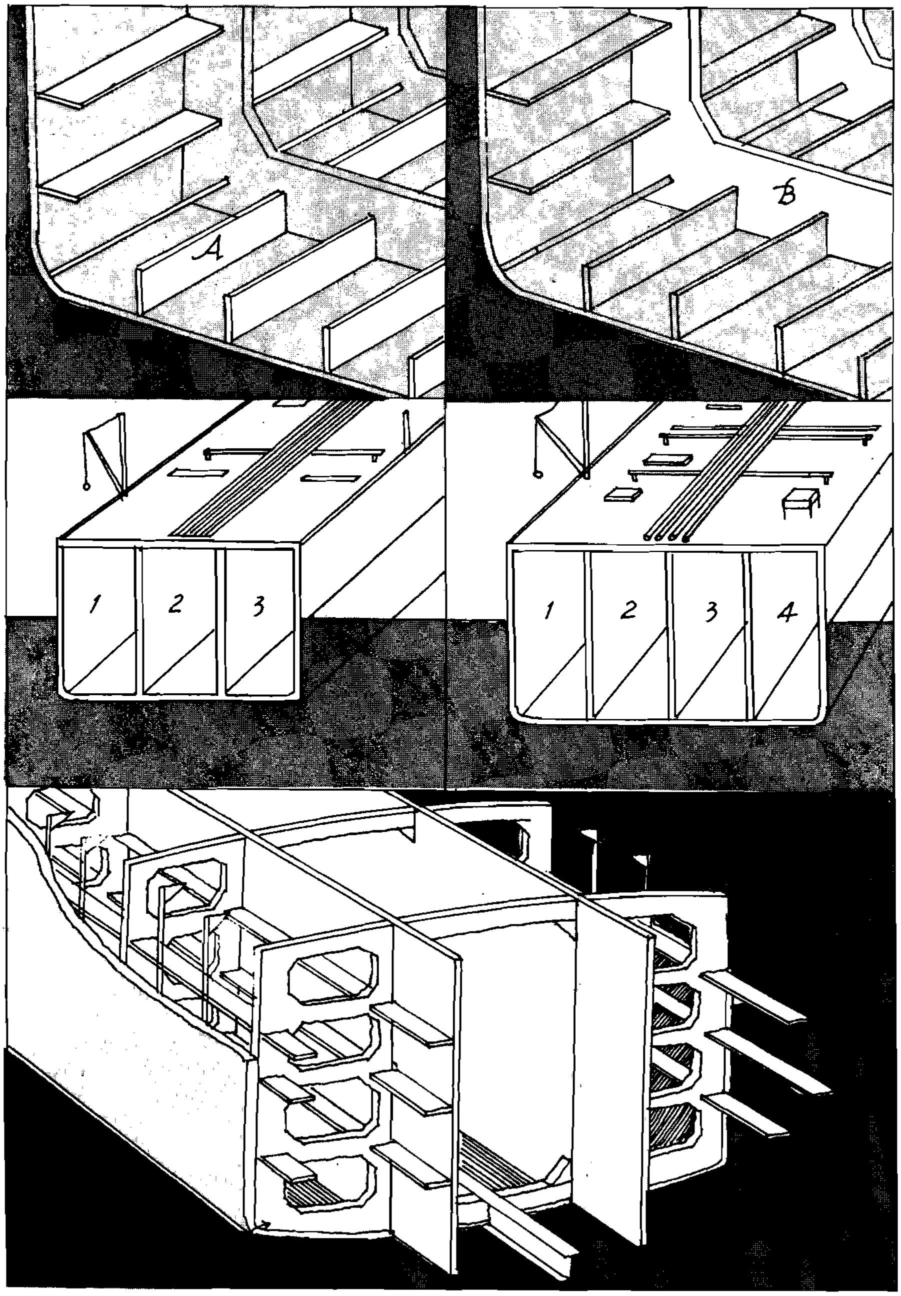


Figure 6

In the most efficient structural arrangement for tanks, longitudinal framing of shell plates is used to provide maximum buckling resistance for plate panels. These are supported by a system of deep transverse members, which in turn are supported by two longitudinal bulkheads in most tankers. Ultra Large Crude Carriers usually have three longitudinal bulkheads because of their size. The structural members are subdivided into a series of increasingly smaller, yet finite, elements whose interaction with one another can be determined by a computer. This finite-element technique has become the basic tool of structural engineers in the aerospace industry as well as the shipbuilding industry.

Maintaining structural integrity

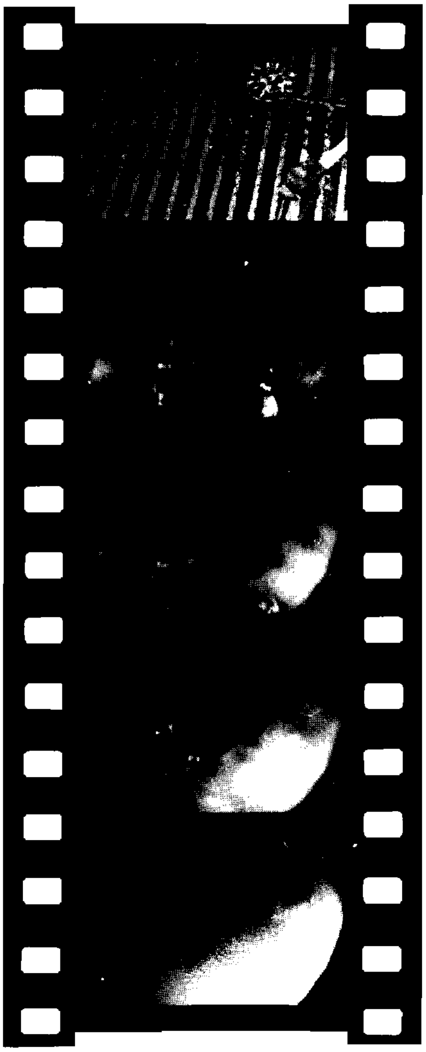
Of course, the sea has not changed since the first tanker was designed, but in a century, tankers have increased in size 175 times. In spite of this growth, the structural reliability of tankers has actually improved. In fact, enhanced structural design, along with economies of scale and better shipyard procedures, caused the actual cost per deadweight ton for tanker newbuildings to decrease until the beginning of the 1970s, when inflation reversed the trend.

Even with competent structural design, no ship—no structure, in fact—can provide reliable service unless it is properly maintained. Ship operators must fully understand how a ship's structural reliability is related to loading conditions. In spite of structural improvements in tankers over the years, the potential for tanker failure remains fundamentally the same. If a tanker is improperly loaded, it may give under stress. So, in the final analysis, only proper maintenance of the structure and strict adherence to the rules of tanker loading can ensure tanker integrity. ⚓

This article was developed with the help of Bill Gray, Exxon Corporation, and Stuart Lawrie, Exxon International.

356-450 O - 81 - 2

Tanker Safety Depends on You



It could have been a falling tool . . .

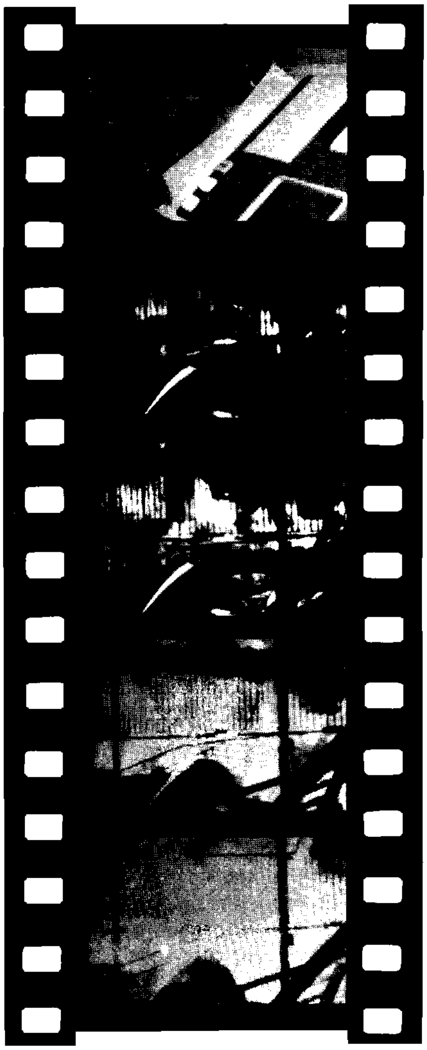
FORT MIFFLIN, Pennsylvania, April 9, 1974 — The M/V ELIAS burned and sank in the Delaware River this evening after sustaining a series of three explosions. Nine members of the crew and four visitors (relatives of the master) died or are missing . . .

LOS ANGELES, December 17, 1976 — Six crewmembers were killed and 22 injured when the Liberian tanker SS SANSINENA exploded and burned in Los Angeles Harbor today. Two crewmembers and one terminal security guard are missing and presumed dead. Thirty-six passers-by were also reportedly injured . . .

DELAWARE BAY, February 12, 1977 — A seaman on board the M/V ELSA ESSBERGER was killed today following an explosion in the forward pumproom shaft entrance . . .

HOUSTON, September 1, 1979 — The tanker SS CHEVRON HAWAII exploded and burned today while moored at a refinery dock. Three members of the crew died, and four were injured. Several employees of the refinery also suffered injuries when an onshore storage tank exploded and burned and a number of tank barges moored at the dock caught fire . . .

It could have been a breaking light bulb . . .



It could have been a spark from a telephone . . .

One minute an oil tanker is peacefully at anchor. The next minute it is engulfed in flames, following a massive explosion. What set it off?

It could have been a falling tool. It could have been a breaking electric light bulb, a spark from a telephone, or a seaman smoking.

Whatever the source, it ignited the vapor given off by the cargo of an oil tanker.

In the case of the SS SANSINENA, the vapor was hanging over the afterdeck. Ballasting was going on. There were holes, concealed by paint, in vent piping. Shelter-deck doors and ullage holes were open.

On the ELIAS, crude oil vapors found a path from a cargo tank to the midship house through holes in vent systems, bulkheads, and drainpipes. Possible ignition sources include gyro equipment, a hot plate, lights, and smoking in areas normally considered safe.

Vapors in the pump room of the ELSA ESSBERGER exploded when an electric light was turned on. The pumproom fan was inoperative.

Lightning may have ignited vapors that led a trail of flame into a cargo tank in the CHEVRON HAWAII.

All of these disasters have two things in common. All of them occurred aboard crude oil tankers, and all of them might have been prevented if enough people had understood one simple fact:

It could have been a seaman smoking . . .

Tanker safety depends on you.

The transport of oil by tanker is one of the largest and most important enterprises in the world today. In a year's time, more than 3,000 tank ships carry 1.5 billion tons of crude oil to an estimated 365 ports in 100 nations.

Tankers carry irreplaceable fuel for business, industry, transportation, and home heating. This all-important task is performed with remarkable efficiency in all respects but one: safety. The sad fact is that, worldwide, loss of life on tankers has risen tenfold in recent years.

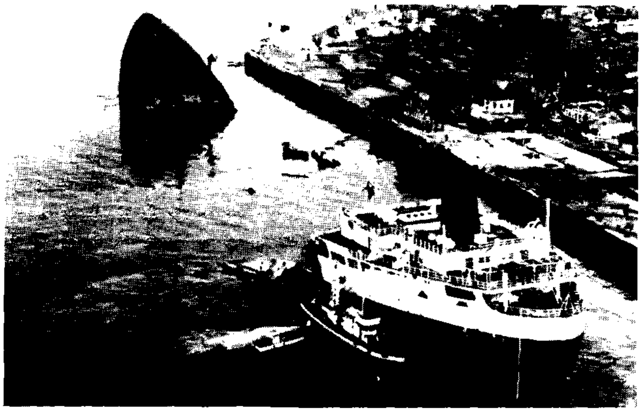
Two factors can be blamed for this loss of life: inadequate shipboard maintenance and failure to take normal safety precautions. Both can be traced to a single, underlying cause: the fact that too few people recognize the many dangers of transporting crude oil.

Many people picture crude oil as they would tar or asphalt. They think of it as a thick, heavy substance that normally has to be heated to be pumped—hardly a substance to be feared.

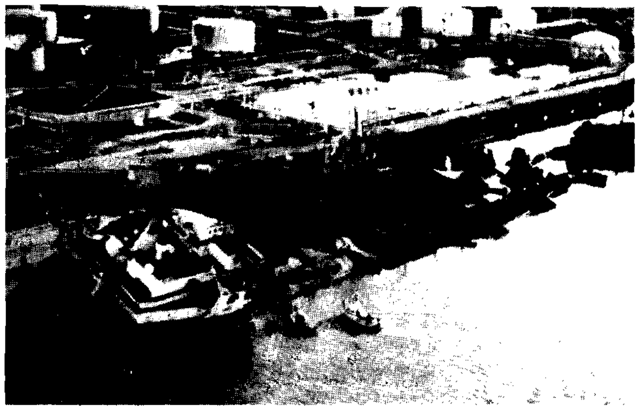
These people are dangerously wrong.

All oil consists of basically the same thing: a compound of hydrogen and carbon. Hydrocarbons such as gasoline, kerosene, and propane have differing flash points. The term "flash point" is easily defined. Liquids don't burn, but vapors do. As a liquid is heated, it gives off vapors. Eventually, enough vapor is given off that, when mixed with air, the vapor can support combustion. The temperature of the liquid at that point is called the flash point.

Three things are necessary for fire: fuel (crude oil, in this instance), oxygen, and an ignition source—



After the explosions: the SS SANSINENA . . .



. . . and the SS CHEVRON HAWAII.

something to start the fire.

Remove the oxygen, and the fire goes out. Remove the concentration of vapor, by ventilation, and there can be no fire. Remove the ignition source, and no fire is possible. But combine all three, and you get fire. If the fuel is contained in an enclosed space, such as a pumproom or cargo tank, the fire can become an explosion. As pointed out earlier, there are many possible ignition sources: a spark from a hand tool, a broken light bulb, a defective switch, a faulty hot plate, an open flame from a match or torch.

Safety precautions and shipboard maintenance are interdependent. If ignition should accidentally take place, a vessel's flame screens are designed to prevent flames from penetrating the cargo tanks. A hole the size of a pin, however, can render a flame screen useless. It is necessary, therefore, to 1) eliminate ignition sources and 2) practice good maintenance. The latter will protect you from the accidental ignition of vapors from sources beyond your control.

A tanker docked at an East Coast terminal will serve as an example of safe work practices. The chief mate and the terminal officer go through their safety checklist before starting to unload the vessel's 200,000 barrels of oil. A Coast Guard officer arrives to conduct a routine safety inspection. He ensures that proper procedures are indeed being followed: a bonding cable has been secured, ship to shore, to eliminate arcing when the hoses are hooked up. Warning signs have been posted ashore and on the ship. Radar and radio equipment have been shut down. Doors, windows, and ports are closed. Ventilators are trimmed to prevent the entry of vapor. Flame screens are inspected. When a faulty one is found, it is replaced on the spot.

Smoking on deck is prohibited. There is a danger that vapors will accumulate and become trapped in pockets near the superstructure.

Small details cannot be overlooked, nor can larger problems—holes in vent systems, loose connections in piping, inoperative ventilator fans. All must be put in order. All of these safety measures are important, whether the ship is loading, unloading, or ballasting.

The pumproom is the most dangerous place in the ship, since it is there that vapors tend most to concentrate. It must be kept clean and free of flammable liquids in the bilges. Seals and glands must be tight and well-maintained. There must be a powerful ventilating system.

Once the inspection is complete, the unloading can begin.

Loading and ballasting are even more hazardous than unloading because they drive large volumes of vapor out of the cargo tanks. In order to relieve the pressure in the tanks, some ship crews try to speed up

Proper Flame Screens Can Prevent Disasters

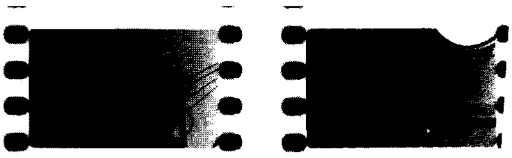
Openings to cargo tanks carrying flammable products should be protected by flame screens. This prevents flames and sparks on deck from igniting the cargo tank contents and causing a catastrophe. Recent studies conclude that this is true not only for crude oil and gasoline but for most flammables carried on tankships and barges.

Two types of flame screen are Coast Guard-approved: 1) a single 30 x 30 mesh screen or 2) two 20 x 20 mesh screens separated by at least ½ inch but no more than 1½ inch.

For a flame screen to be effective:

- it can have no holes or tears larger than the original mesh size
- it must be properly mounted in its supports with no voids or gaps around the edges, and
- the screen support must be properly mounted in the opening with no voids or gaps, and the mating surfaces must be free of dirt, scale, and corrosion.

Through inspection, proper maintenance, and timely replacement, this potential safety hazard can be eliminated.

The safety measures shown here might have prevented the explosions described on the preceding pages. Clockwise from left are: securing a bonding cable ship to shore; posting warning signs; shutting down radar and radio equipment; closing doors, windows, and ports; inspecting flame screens and replacing faulty ones; extinguishing cigarettes, and checking for holes in the ventilating system.

the process by opening lids and ullages. This allows vapors to accumulate on deck and creates a major safety hazard. Tanks should be vented though the established venting system only.

Such routine procedures may seem unnecessary when no danger appears to exist. The need for them has been established by hard experience, however.

Remember the ELIAS.

Remember the SANSINENA.

Remember the ELSA ESSBERGER.

Remember the CHEVRON HAWAII.

Remember the experience of the United States Coast Guard. The Coast Guard's duty is to enforce all Federal laws and international treaties in the navigable waters of the United States and to conduct the inspections necessary to carry out that duty.

The Coast Guard's mission is safety. The rules it asks you to observe and the advice it offers and exchanges with you are based on the many years of coordinated efforts between the Coast Guard and industry to improve the design, maintenance, and handling of seagoing vessels.

Tanker safety requires a unique kind of democracy in which every man's life depends on the efficiency of every other man aboard.

No matter how careful others may be, any man—from master to seaman—can destroy a ship simply by lighting a cigarette or failing to repair a vent or close a lid.

And any man—from seaman to master—can take that one step that protects his ship, his shipmates, and himself from disaster. You will be safe only when you realize one simple fact:

Tanker safety depends on you. ⚓

The 12-minute film titled "Tanker Safety Depends on You" is available for review at any Coast Guard District Public Affairs Office and may be purchased in 16 mm or Betamax 1 format or 3/4 Umatic directly from:

WRS Motion Picture Laboratories
210 Semple Street
Pittsburgh, Pennsylvania 15123

Coast Guard Tests New Surf Boat

by PA2 Gregory Creedon
Third Coast Guard District

The U.S. Coast Guard recently took delivery of a British-made rigid hull inflatable boat (RHI) as part of a pilot program to determine the boat's feasability in surf and inlet operations.

The "Arctic 24," with some Coast Guard-ordered modifications, was manufactured by Osbourne Rescue Boats, Ltd., Hampshire, England, and was delivered to the Coast Guard station at Beach Haven, New Jersey, in August.

The RHI, developed for use in the North Sea oil fields, is being tested in the rough inlet waters of the New Jersey shore as part of a pilot program being run to find an eventual replacement for the Coast Guard's 25-foot motor surf boats.

In appearance the Arctic 24 is similar to other RHIs now in use throughout the Coast Guard. Its performance, however, surpasses the service's other boats.

The most striking difference in appearance is the self-righting cage located over the engines. If the boat capsizes, a "D" ring operated by the coxswain actuates a gas system, inflating a bag which will right the craft in 15 seconds.

Equipped with twin Johnson V4 Seahorse 90 horsepower engines, the RHI has a top speed of 35 knots, depending on the loading of the craft and sea conditions. The engines are equipped with Power Trim 'N' Tilt to facilitate the boat's use in shallow water.

Length overall is 24 feet (7.32 meters). Length of the fiberglass rigid hull is 21 feet 3 inches (6.47

meters). The beam overall is 8 feet 7 inches (2.62 meters), and the beam of the rigid hull is 6 feet 7 inches (2.01 meters). The draft of the boat with the engines up is 1 foot 5 inches; with the engines down, it is 2 feet 4 inches. The boat will hold up to 15 people if necessary.

Located in the center of the craft is a command console in a three-person cloverleaf design, accommodating a coxswain and two crewmembers. The console has wheel steering and readily accessible engine controls at the operator's right hand. A waterproofed VHF radio with controls usable through a plastic panel is installed behind the coxswain. Also in the command console are the electrical equipment and two maintenance-free batteries.

The crew is seated side-by-side behind the coxswain on padded seats with a grab bar in front. Toeholds are provided for the coxswain and the crew. Instrumentation includes a stop button, choke starter switch, temperature warning light, and tachometer for each engine. Also included are switches for the navigation lights, panel lights, radio, etc.

Behind the command console, a standard Coast Guard dropable pump is secured to the deck. Further aft, heavy-duty towing equipment is installed, incorporating a manually cranked reel with 300 feet of two-inch towing line.

The topside is formed by a neoprene inflated tube or collar divided into separate compartments secured to the hull deck edge. If a compartment is punctured, membranes in adjoining compartments will fill the damaged portion. A heavy-duty abrasion collar is fitted to the outboard portion of the topside. Grablines are fitted to the rubber collar to help people in the water.

The Arctic 24 has a deep "V" hull used on other Osbourne craft and is designed for on- or offshore service. The craft is virtually unsinkable and, dynamically and statically, is exceptionally stable. Since its deck is higher than the waterline and it has an open transom, any spray or sea water entering the boat will be quickly freed—an important fact when the boat is alongside a disabled craft in breaking surf conditions.

Below the deck of the rigid hull is a 40-gallon fuel tank, which gives the Arctic 24 an endurance of around 100 nautical miles. In addition, the RHI carries two six-gallon auxiliary fuel tanks.

The cage over the Arctic 24's engine holds a gas-actuated system which will right the boat within 15 seconds of a capsize.

The Arctic 24 would hold 15 people and a third crewman in addition to the two shown above. The grablines along the sides of the boat are for people in the water.

The RHI was put to a test recently as ten-foot waves and five-foot swells from Hurricane Dennis hit the Beach Haven inlet. A call came into the station; a Boston Whaler had capsized in the inlet, throwing one person into the water. The RHI raced from Station Beach Haven, which is four miles from the inlet, and was on scene in ten minutes. The same trip in the station's 44-foot patrol boat or 25-foot motor surf boat would have taken 45 minutes.

Racing through the waves with an ease unknown in previous Coast Guard surf boats, the RHI and its three-man crew found the capsized boat quickly. With the RHI's installed towing equipment, the crew had no problem towing the boat through the heavy surf to safety.

Crews operating the new Arctic 24 all use superlatives when speaking of their station's new boat. Station Beach Haven Executive Officer Chief Charles Brittingham noted that the craft had over 100 hours of use in less than two weeks. He said that the boat had the tightest turning radius of any current Coast Guard boat and demonstrated its prowess by executing a full-speed figure eight in an area 100 feet long.

Mariners in the Beach Haven area have noted the arrival of the new Arctic 24. Those who have seen it dash into the surf at high speed know the Coast Guard is now better equipped to come to their aid if the need ever arises. ⚓

Maine Maritime Academy Develops Center for Advanced Maritime Studies

by Captain George M. Marshall, Director

The administration of Maine Maritime Academy, and in particular RADM E. A. Rodgers, USMS, Superintendent, recognized some years ago that the Academy should play a more active role in continuing education in the maritime field. This decision took into account the need for improved shipboard management performance and recent experiments in the decentralization of management in shipping. The following article provides background information on Maine Maritime Academy and discusses the recently established Center for Advanced Maritime Studies.

Maine Maritime Academy Has 40-year History

On March 17, 1941, the Maine State Legislature enacted a bill creating the Maine Nautical Training School (later changed to Maine Maritime Academy). The first 28 students were enrolled on October 9, 1941, and housed in the Pentagoet Inn in Castine, Maine. The school moved to its present location in 1942, taking over the buildings and grounds of the former Eastern State Normal School. Class size and curriculum fluctuated as the Academy worked to fill the increased demand for merchant marine and Navy officers during World War II. In 1946 the curriculum was established as a three-year program, and in 1960 it was expanded to four years. Enrollment was increased to its present maximum level of 650 in 1976, when reaccreditation of the Academy's baccalaureate degree program was approved.

In the mid-1960s the Academy embarked on a major program of campus development and curriculum improvement under the administration and leadership of Superintendent RADM E. A. Rodgers. The Academy's primary mission was and continues to be to provide a comprehensive course of instruction and training to qualify men and women as U.S. Coast Guard-licensed officers in the U.S. Merchant Marine.

A Need Seen for Advanced Training

In more recent years the steady advance of maritime technology, the rapid rate of change in ship operating practices, vastly improved management information systems utilizing computer technology and satellite communication equipment, and increasing concern over safety and the environment indicated the need for advanced level (postgraduate) special short-course training and educational programs for the maritime industry. Such training will become a requirement for maritime nations subscribing to the Inter-Governmental Maritime Consultative Organization (IMCO) International Convention on Standards of Training, Certification and Watchkeeping, 1978, upon its entry into force. Although there are a few union-operated schools which prepare their members for license upgrading, not all operators have access to the union schools. Independent facilities for the retraining and advanced training of ship's officers and shoreside managers are therefore needed.

With the foregoing in mind, Maine Maritime Academy decided to conduct a feasibility study on the needs and uses of a Center for Advanced Maritime Studies. In March 1978 the Academy held a symposium on the topic of the proposed Center. All segments of the U.S. Merchant Marine were represented. This exercise provided a foundation for the maritime industry survey subsequently carried out by A. T. Kearney, Inc., in collaboration with the Academy. The final report submitted by A. T. Kearney, Inc., in September 1978 convinced the Academy to go ahead.

Facilities Developed

In January 1979 the Academy launched a $3 million capital fund drive. The number one priority was to obtain funding to reconstruct and renovate an existing building, Leavitt Hall, to house the Center for Advanced Maritime Studies (CAMS) and some of the administrative offices. Work began in November 1979 and was completed at the end of 1980. The building was ready for occupancy in January 1981, and CAMS was dedicated on March 8, 1981.

In addition to housing CAMS, Leavitt Hall is also available—to the extent that it is not needed for educational and training programs—as a Conference

Center facility. The hall contains lodging for program participants and a variety of conference and meeting areas, including an 85-seat lecture hall and a 300-seat auditorium. Dining facilities are located nearby in the Alumni House. A new, modern library is located in an adjacent building. A wide range of recreational facilities is available to guests and students attending short-course programs and to those who use the Center.

Curriculum Tailored to Students' Needs

The immediate objective of the Center for Advanced Maritime Studies is to sponsor and cosponsor courses and seminars designed to meet the needs of mariners seeking to improve their professional skills and competence. Some of the classes developed thus far by the Academy's faculty are license upgrading courses, programs for radar recertification, and collision avoidance training. In July 1981 a five-week U.S. Coast Guard-approved marine diesel training program was initiated. In August 1981 CAMS cosponsored, with the Association of Water Transportation Accounting Officers, a two-day seminar on Ocean Transportation Finance. In September 1981 CAMS sponsored two one-week (back-to-back) courses in inert gas and crude oil washing; instructors for these courses were supplied by Wilson Walton International, Limited, and the College of Nautical Studies of Warsash, Southhampton, England. CAMS will also collaborate with the just-named College in sponsoring a tanker safety course and shipboard management training program in 1982.

One of the first courses developed by CAMS was Ship's Medicine (the first session was held in January 1981). This comprehensive course, an intensive one-week seminar, is designed to prepare the shipboard officer to handle serious medical and surgical emergencies which may arise at sea. Classroom lectures are combined with practical experience in treating a variety of medical problems. Participants in this seminar learn how to:

- Determine the extent of illness or injury
- Administer Cardiopulmonary Resuscitation (CPR)
- Control bleeding
- Treat soft-tissue injuries
- Treat injuries to the skull, brain, neck, and spine
- Carry and transport the seriously injured
- Treat burns
- Recognize digestive and excretory system ailments
- Recognize and treat shock
- Utilize background medical history
- Understand basic physiology
- Treat explosion, drowning, electrical, and radiation injuries
- Recognize and treat communicable diseases
- Recognize drug and alcohol abuse
- Treat hypothermia and practice cold water survival techniques

CDR Robert F. Russell, M.D., teaches students attending the one-week Ship's Medicine Course how to transport injured seamen correctly.

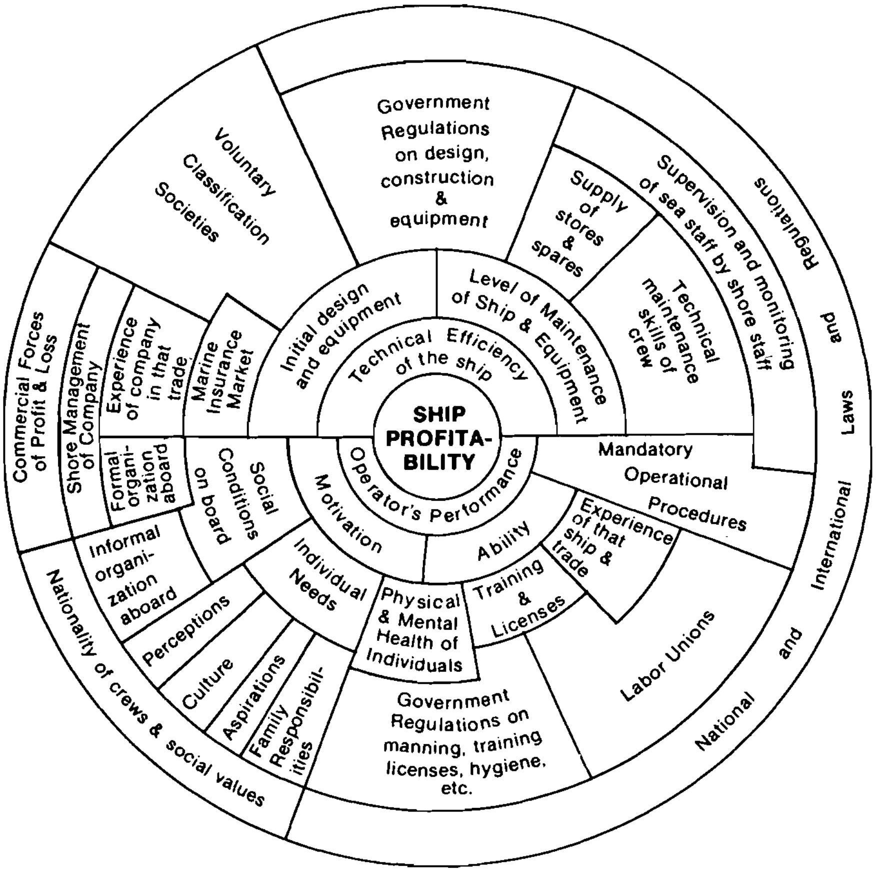
Dr. David H. Moreby, Dean of the Faculty of Maritime Studies at England's Plymouth Polytechnic, conducts a seminar on The Management of Change Aboard Ship.

The differences between a medical emergency ashore and a medical emergency afloat are also discussed.

In the week following its dedication, CAMS sponsored "The Management of Change Aboard Ship," the third in a series of Human Factors Seminars. The first two such seminars had been sponsored by Maine Maritime Academy, starting in October 1978. The Academy's 1978 Faculty Seminar had focused attention on the need to respond to technological and social advances by paying more attention to the "human element" in shipping operations. The large percentage of human error in casualty statistics (principally among seamen with considerable at-sea experience), indicates the importance of this element. The seminars have dealt with such issues as: What factors contribute to a healthy or negative attitude onboard merchant vessels? What design changes could be made to improve the physical environment in which mariners work? Does automation lead to complacency or negligence? How are jobs and job satisfaction changing aboard modern ships? CAMS and the Academy hope to hold periodic forums on human factors.

Expansion of Curriculum Planned

On the drawing board in various stages of development are short courses in maritime law and regulation, ship's business, seaman's accident and illness claims



Dr. Moreby designed a diagram to show the many factors which have a bearing on ship profitability and the relationships between the factors. Profitability was one of the subjects addressed by the Human Factors Seminar III, The Management of Change Aboard Ship, held in March 1981.

Factors Affecting Ship Profitability, copyright 1981 by David H. Moreby

administration, maritime weather, maritime industrial relations, shipping economics and finance, and fire-fighting and damage control.

Looking ahead to the future, Academy officials are paying increasing attention to the need for advanced degree programs in the field of maritime education and training. They are placing particular emphasis on improved shipboard management performance and the need to prepare officers for the transition from positions at sea to important managerial positions ashore. Further expansion of the school's short-course training programs awaits only the funding needed both to design and develop the courses and to attract competent faculty members from the private sector of the maritime industry. Since total undergraduate enrollment has been stabilized at its present level, Maine Maritime Academy now intends to devote more of its human and financial resources to the development of an outstanding continuing maritime education program. ⚓

Inquiries concerning CAMS programs should be directed to the author, Captain George M. Marshall, Director of Center for Advanced Maritime Studies, Maine Maritime Academy, Castine, Maine 04421; (207) 326-4311, ext. 212.

About the Author

Captain George M. Marshall, the Director of the Center for Advanced Maritime Studies, also serves Maine Maritime Academy as Chairman of the Development Council and Director of Development, Placement and the Cadet Shipping Training Program. Captain Marshall has served as a deck cadet and in all deck officer positions including master in the U.S. Merchant Marine. Since World War II, he has accumulated some 30 years' experience as an underwriter, manager, and senior officer in marine and international insurance operations. He has been with the Academy since 1975.

Lessons from Casualties

In September of 1980, in the middle of a hot day, a tank barge carrying methanol (methyl alcohol) exploded violently while underway on the Ohio River. In a 14-barge tow, the methanol barge and one other barge were at the rear of the tow and being pushed backwards. This placed the bow of the methanol barge right next to the towboat. The investigation revealed a number of factors that more than likely caused the explosion.

1. When the barge was being cleaned prior to loading, a quantity of methanol apparently was drained into the bow rake compartment which housed the cargo pump and associated underdeck cargo piping. This is disputed, but five days later a liquid visually identified as "water" was observed in that compartment during checkoff just before loading. The amount of "water" was not large enough to cause alarm. Methanol is a colorless liquid resembling water (as are several other hazardous liquids), and its vapors are described in the CHRIS manual as being irritating. Depending on prevailing conditions, it would be possible to observe the liquid without smelling the vapors, in which case it could be mistaken for water.

2. There were three paths of escape for vapors in the bow rake. There were two vents, a high vent and a low vent (though the low vent was probably blocked by the liquid in the bottom of the compartment), and a three-foot by three-foot spring-assisted hatch which provided access into the compartment. When this hatch was not dogged down—and it was not dogged at the time of the explosion—a gap remained through which vapor could exit. There were also fractures in the starboard bow corner.

3. Immediately after the explosion, flames and smoke were observed on the bow of the towboat where synthetic lines and diesel fuel were stored for operating small pumps. However, the area of this fire was shielded from the explosion fireball by the four tow knees. Furthermore, synthetic lines are not readily combustible (when exposed to intense heat they melt and puddle), and samples of the diesel fuel found in that area were tested by the Kentucky State Police Crime Lab and found to have a flash point between 110°F and 190°F. The ambient air temperature was 91°F, and the diesel fuel was stored in the shade. Both the synthetic line and the diesel fuel would have had to be heated for some time before they burned. In other words, there was probably a small fire burning on the bow of the towboat before the explosion, and this fire was probably the source of ignition for the explosion.

4. Cigarette butts could be seen in photographs of the debris taken on the bow of the towboat after the fire had been put out. A later photograph of the same location on the towboat also showed cigarette butts there. The captain, the pilot, and all three deckhands on board were smokers. The source of the cigarette butts in the fire area was unclear, but one possibility was identified. The center window in the pilothouse was open at the time of the explosion, and the area of the fire was within range of a "flicked" cigarette butt. This area was not within view from the pilot's normal operating station.

There are several points worth noting in this case. It appears that proper care was not taken in the cleaning of the barge. Subsequently, the failure to determine whether the liquid in the rake was water or methanol set the stage for disaster. The location of the tank barge with a volatile cargo next to the towboat may not have been necessary and does not appear to have been considered by the crew. Even if there had been no fractures and the hatch had not been left undogged, venting of vapor could have been expected on a hot day, and the possibility of vapor streams from a barge a few feet away (or even farther up in the tow) would have been a good reason to prohibit smoking on deck. The cigarette butts observed in various places on deck during the investigation are indications of misuse of smoking materials. The debris from the fire on the towboat and the fire itself suggest sloppy housekeeping, possibly including spillage of flammable liquids.

* * * * *

At 3:46 a.m. on November 24, 1980, at mile 7.7 Above Head of Passes in the Mississippi River, a chemical tank ship collided with and sank an oil field supply vessel. This occurred just below Venice, Louisiana, where the traffic is particularly heavy. The two vessels were in a meeting situation, with the tankship outbound. The situation was complicated by the fact that at the moment of the collision the tankship was also right at the point of meeting another large vessel. This limited the options available to the pilot on the tankship, who feared losing control and colliding with the large vessel.

In the 5½ minutes prior to the collision, the pilot on the tankship ordered or himself executed three radio transmissions, three whistle signals, and three course changes, all designed to facilitate a safe meeting with the supply vessel. The final whistle signal was a danger signal with 10 to 12 blasts, and just after it was given the supply vessel veered under the bow of the tankship. A more timely danger signal <u>might</u> have attracted the attention of the crew on the supply vessel, but both of the two-whistle signals before the danger signal were ignored. It can only be concluded that the crew on the supply vessel was not paying proper attention and that a lookout certainly was not posted. The final maneuver of the supply vessel was probably the result of panic in extremis.

As a result of the collision, the supply vessel capsized and became impaled keel-first on the stem of the tankship, which did not have a bulbous bow. The captain and one of the crew went overboard; they were seen and heard in the water but could not be saved. The water temperature was 57°F. The other two crewmembers were trapped in their staterooms. One drowned immediately; the other found an air pocket in his stateroom and had enough presence of mind to use it, in spite of hallucinations caused by a blow to the head received in the capsizing.

The tankship, with the supply vessel wrapped around its bow and unable to drop its anchors, eventually grounded at mile 5.2. Coast Guard personnel from Station Venice were checking the hull of the supply vessel when the trapped survivor heard them by holding his hairbrush up against the hull. He banged on the hull with the hairbrush and anything else within grasp and managed to make himself heard. A jack-up vessel with three legs that could be lowered to the bottom of the river for support was brought down from Venice and used to keep pressure on the supply vessel to prevent it from dislodging from the bow of the tankship. Around 9:45 a.m. a diver entered the hulk and found the survivor, who by this time was shaking violently from the cold. The diver offered him a scuba tank, but he was unable to use it. The diver then radioed for a diving helmet, and another diver brought one down. With this equipment and the first diver's help, the survivor was brought to the surface, taken to a nearby barge, picked up by a Coast Guard H-3 helicopter, and flown to West Jefferson Hospital, where he recuperated for several days.

Nothing more needs to be said about the need for attentive watchstanding. The truly remarkable feature of this case is that the trapped crewman was rescued. ⚓

Coast Guard and NTSB Sign Memorandum of Understanding

A Memorandum of Understanding (MOU) regarding marine accident investigations was signed by the Coast Guard and the National Transportation Safety Board (NTSB) on September 28, 1981.

Effective immediately, the following guidelines will apply in carrying out the provisions of the joint regulations governing "Coast Guard/NTSB Marine Casualty Investigations" (49 CFR 850 and 46 CFR 4.4):

1. The NTSB will investigate all collisions between a Coast Guard vessel and a nonpublic vessel involving at least one fatality or $75,000 in property damage.

2. When mutually agreed by the two agencies, the NTSB will investigate any public vessel/nonpublic vessel casualty resulting in at least one fatality or $75,000 in property damage or any major marine casualty which involves significant safety issues relating to Coast Guard safety functions, e.g. SAR, ATON, VTS, marine inspection, etc.

3. The accident investigation roles of the NTSB and the Coast Guard with respect to all other accidents within the scope of the joint regulations will continue unchanged for the interim.

In general, when the NTSB conducts the marine accident investigation in the cases cited above, the procedures followed will parallel, where applicable, those described in 49 CFR 831 with respect to aircraft accidents/incidents. When the NTSB conducts a public hearing in connection with the accident investigation, the procedures followed will be those described in 49 CFR 845.

Contact Lens Wearers, Beware!

The National Society for the Prevention of Blindness has recently come out strongly against the use of contact lenses in industry.

Much of its warning could also apply aboard any vessel. Consider:

- Far from protecting your eyes, contact lenses actually pose a greater hazard, and safety goggles or full face shields must still be worn.
- If you were to splash something in your eyes such as a chemical and were incapacitated, imagine someone else trying to remove your contact lenses and delaying the flushing of your eyes with plenty of water.
- In dusty areas, small foreign particles which normally would be washed away by tears may be trapped beneath the lenses and damage the corneas of your eyes.
- Electric arc flashes from a short circuit can cause the lenses to adhere to your corneas! (We would think arcs from welding would even be worse)
- Contact lenses can pop out or slip out of place, causing a sudden change in vision. Imagine working on a lathe or drill press and suddenly not being able to see what you were doing.
- Deck men in particular, when standing watches or lookout, could run into the problem of "spectacle blur." Blurred vision can occur for over an hour after lenses are put in or taken out. You'd have to put them in an hour before you went on watch to be sure not to miss anything. Similarly, after taking them out, you should not move around too much for an hour or so to prevent slips, falls, or bumps.

All in all, it sounds as if the only thing they're safe for aboard is reading in your room. However, if you do wear them, it's your decision, but take care.

(Reprinted from LIFELINE, Vol. V - Sec. 2, Ships' Operational Safety, Inc.)

Trichloroethylene
$CHCl = CCl_2$

synonyms:	Trichlor TCE
Physical Properties:	
boiling point:	86.7^{o}C (188^{o}F)
freezing point:	-87.1^{o}C (-125^{o}F)
vapor pressure at 20^{o}C (68^{o}F)	57.8 mmHg (0.076 atm)
Densities	
liquid density:	1.465 (water = 1.0)
vapor density:	4.54 (air = 1.0)
Threshold Limit Values	
time weighted average:*	50 ppm (0.005%); 270 mg/m^3
short term exposure limit:*	150 ppm (0.015%); 805 mg/m^3
Identifiers	
UN Number	1710
CHRIS Code	TCL

* Limits proposed by the American Conference of Governmental Industrial Hygienists in the 1980 edition of its guide to Threshold Limit Values.

The chemical trichloroethylene (TCE) is important primarily because it is such an excellent solvent and does not burn easily. The first TCE was synthesized (produced synthetically) back in 1864, but the substance was not produced commercially on a large scale until the 1920s and 1930s, when a heavy demand arose for TCE to be used in metal degreasing and the dry cleaning of clothing. About 80 percent of the TCE produced in the U.S. today is used in metal degreasing. Of the remaining 20 percent, about half is exported, and the other half goes into either the manufacture of such products as paint solvents, rubber solvents, and polyvinyl chloride or the dying of textiles.

One commmon method of degreasing metals consists of placing the metal in TCE vapor and allowing the hot vapors to condense on it. TCE is one of the best solvents available for metal degreasing and is used in cases where clean metal surfaces are critical—rocket parts, for example.

As stated above, TCE is a synthesized product. It does not exist naturally. The substance is made by adding chlorine to acetylene, ethylene, or dichloroethane. The rising cost of acetylene has caused producers to turn more and more to ethylene and dichloroethane as a starting material.

In the last few years, evidence has begun to accumulate that TCE is toxic and, under certain circumstances, flammable. The demand for the chemical has thus begun to decline as substitutes for it have been found.

Tests have shown that inhalation of TCE vapor depresses the central nervous system and, at high concentrations, causes headaches, nausea, fatigue, and, in extreme cases, unconciousness and death. Estimates are that a concentration of as little as 3000 ppm (0.3%) can cause unconciousness in less than ten minutes. Unfortunately, the sweet odor of TCE is not really a good warning sign, since it is not at all unpleasant and deadens one's sense of smell. Anyone who must enter spaces filled with high concentrations of TCE should use a self-contained breathing apparatus. If someone is exposed, he should be taken into fresh air and a doctor called. Ingestion, or swallowing, of TCE can damage the liver, kidneys, and heart and can be fatal. A victim should <u>not</u> be forced to vomit. Again, a doctor should be called. If liquid TCE spills on the skin, the affected area should be washed with soap and water. Eyes should be flushed with water for at least 15 minutes and a doctor called. Like many chlorinated hydrocarbons, TCE has been shown to cause cancer in laboratory animals. As a result of all of these findings, the concentrations to which an employee may be repeatedly exposed have been lowered to 50 ppm for prolonged exposure and 150 ppm for short-term exposure. The toxic hazard is the major cause of the decline in the demand for TCE.

For a long time TCE was called nonflammable, but several accidental fires and at least one experimental program have demonstrated that the chemical is indeed flammable. According to the Bureau of Mines, a flammable mixture in air will not form below a temperature of 30^{o}C (86^{o}F). At 30^{o}C, TCE becomes flammable at a minimum concentration of 12.5 percent. A flammable mixture is thus possible at or above room temperature. One important caution for smokers: TCE inhaled through a burning cigarette can form phosgene, which is toxic and was used as a poison gas in World War I.

Trichloroethylene can oxidize (and thus lose its purity) in the presence of air, so it is usually stabilized for shipping and storage, i.e., a chemical is added to prevent oxidation. The tanks in which it is shipped are commonly made of steel and iron.

The Environmental Protection Agency classifies TCE as a Category C pollutant, while the Inter-Governmental Maritime Consultative Organization designates it a Category B Pollutant. Although the Coast Guard did not regulate TCE in the past, the suspected carcinogenicity of TCE has moved the Coast Guard to regulate it in Title 46 of the Code of Federal Regulations, Parts 151, 153 (proposed), and 154a. The Department of Transportation regulates TCE in Title 49 of the Code of Federal Regulations, Part 172.

ALAN SCHNEIDER, Sc.D., and CURTIS PAYNE, B.A.
HAZARD EVALUATION BRANCH
CARGO AND HAZARDOUS MATERIALS DIVISION

Marine Safety Council Membership

Rear Admiral Robert S. Lucas
Chief, Office of Engineering

Robert S. Lucas was born on July 6, 1930, in Hutchinson, Kansas, and graduated from Gresham Union High School in Gresham, Oregon, in 1948.

He was appointed a cadet to the Coast Guard Academy in New London, Connecticut, and graduated with a Bachelor of Science Degree and a commission as Ensign in June 1952.

His initial assignments from the Academy were Deck Officer aboard the United States Coast Guard Cutters FORSTER, VANCE, AND BUTTONWOOD and Student Engineer/Assistant aboard the USCGC NORTHWIND and the USCGC WACHUSETT. In May 1955 he became the Commanding Officer of Coast Guard LORAN Station ENIWETOK in the Marshall Islands. He was subsequently transferred to the Captain of the Port Office in Honolulu, there to serve as Executive Officer. In June 1957 he entered the Massachusetts Institute of Technology in Cambridge, Massachusetts, from which he later received a Master's Degree in Naval Architecture and Marine Engineering.

He was then assigned to the USCGC WINNEBAGO as Engineering Officer. In July 1962 he became Chief of the Naval Engineering Branch of the First Coast Guard District. His next two assignments were aboard the USCGC WACHUSETT, first as Executive Officer and then as Commanding Officer.

He next assumed the post of Commanding Officer of the Resident Inspector Office in New Orleans, Louisiana. In July 1972 he became Chief of the Special Projects and Systems Branch at Coast Guard Headquarters. Remaining at Headquarters for his next two assignments, he served as Assistant Chief and then Chief of the Naval Engineering Branch. In July 1976, he began two tours in the Seventeenth Coast Guard District, first as Chief of the Operations Division and then as Chief of Staff.

His next assignment was Deputy Area Commander of the Pacific Area. In June 1980 he was ordered to the Coast Guard Yard in Baltimore, Maryland, to serve as Commanding Officer. He then returned to Headquarters as Chief of the Office of Engineering, in which capacity he is presently serving.

Following is a resume of his appointments in rank:

- Ensign, June 1952
- Lieutenant (junior grade), December 1953
- Lieutenant, July 1956

- Lieutenant Commander, July 1962
- Commander, January 1967
- Captain, July 1973
- Rear Admiral, April 1981

In addition to receiving the Navy Presidential Unit Citation, he has been awarded the Bronze Star, the Meritorious Service Medal, the Coast Guard Commendation Medal, the Arctic Service Medal, the Vietnam Service Medal (with three Bronze Stars), the National Defense Medal, the Korean Service Medal, and the United Nations Medal.

Rear Admiral Lucas is a member of The Society of Naval Architects and Marine Engineers and the American Society of Naval Engineers.

Mrs. Lucas is the former Kay F. Ray of Oak Hill, West Virginia. The couple resides in Arlington, Virginia.

Nautical Queries

The following items are examples of questions included in the Third Mate through Master examinations and the Third Assistant Engineer through Chief Engineer examinations.

DECK

1. The closest horizontal distance that break-bulk hazardous material may be stowed from an operating embarkation point of a lifeboat is

A. 15 feet.
B. 25 feet.
C. 50 feet.
D. 75 feet.

REFERENCE: 46 CFR 176.74 (f)

2. Frames on a tank vessel are numbered in consecutive order,

A. starting forward and working aft.
B. starting aft and working forward.
C. in either forward or aft direction.
D. starting amidships and working in both directions.

REFERENCE: Marton

3. Loran-C can be adversely affected by interference from many sources. To offset this, most manufacturers provide

A. tuneable filters.
B. pre-oscilloscope readings.
C. antenna wave length.
D. pre-tuned A and B phases.

REFERENCE: Bowditch

4. The process of uncoiling manila line in order to prevent kinking is known as

A. flemishing.
B. coiling.
C. faking.
D. thoroughfooting.

REFERENCE: MMOH

5. You are attempting to locate your position with reference to a hurricane center in the Northern Hemisphere. If the wind direction remains steady but with diminishing velocity you are most likely

A. in the right semicircle.
B. in the left semicircle.
C. on the storm track ahead of the center.
D. on the storm track behind the center.

REFERENCE: Donn

ENGINEER

1. If a fire occurs in an electrical cable in which the inner layers of insulation or insulation covered by armor is burning, you should

A. secure power to the cable.
B. cut the cable with an insulated cable cutter.
C. separate the two ends.
D. all of the above.

REFERENCE: Basic Electricity NAVPERS

2. To properly seat brushes on a commutator you should use

A. emery cloth.
B. heavy paper.
C. a file.
D. sand paper.

REFERENCE: Hubert

3. Feed booster pumps operate under suction conditions most similar to which other type of pump?

A. Main feed pump
B. Auxiliary feed pump
C. Condensate pump
D. Main circulating pump

REFERENCE: Harrington

4. The lowest pressure cut-out switch is set to automatically start a refrigeration compressor when the pressure in the compressor suction corresponds to an elevated coil temperature. The normal stopping point of the compressor is set by adjusting the

A. cut-in point of the low-pressure cut-out switch.
B. the low-pressure cut-out switch differential.
C. cut-out point of the high-pressure cut-out switch.
D. high-pressure cut-out switch differential.

REFERENCE: Principles of Naval Engineering

5. Cloudy or milky-appearing oil in a lube oil system could be caused by

A. insufficient cooling water to the lube oil cooler.
B. excessive cooling water to the lube oil cooler.
C. insufficient gland-sealing steam.
D. excessive gland-sealing steam.

REFERENCE: Naval Turbines

ANSWERS

DECK
1.B;2.B;3.A;4.D;5.D
ENGINEER
1.D;2.D;3.C;4.B;5.C

Warning: Fixed Ballast Can Explode

A Military Sealift Command oceanographic survey vessel recently experienced an explosion that killed one man and severely injured two others. The ship was a converted cargo carrier with fixed ballast composed of pig iron ingots with mill scale filling the spaces in between (mill scale is a dense iron oxide material that flakes off steel ingots as they are being rolled into structural shapes and sheets). It was covered by a reinforced concrete cap. The ballast was at the main deck level, filling a hatch coaming and leaving an 18-inch void below the hatch cover. The hatch cover was welded all around without any ventilation to the void space.

The explosion occurred in a shipyard while workers were scarfing a bracket off the top of the hatch cover with a carbon arc (temperature at the tip: 6,000 - 10,000°F). Shipyard personnel exercised better-than-average caution regarding the atmosphere in the void before starting the hot work but failed to detect **methane** and other combustible gases (ethane, propane, and butane) in the void. When all other means of accessing the void and determining its contents had been exhausted, two holes were drilled in the hatch cover, and a Marine Chemist was asked to check the void, even though this was not required. U.S. Occupational Safety and Health Administration Regulations (29 CFR 1915) require only that a "competent person" check such a void, and the Coast Guard does not have any regulations directly applicable to hot work aboard a vessel undergoing shipyard repair. Using a meter calibrated the day before, the Marine Chemist got a reading of "0" for explosive gases and "20 percent" for oxygen. (These readings are questionable. The combustible gas indicator was subpoenaed within three hours by the Coast Guard and checked by a testing laboratory. The batteries were dead, and a tube was disconnected inside.) The result was an explosion that ripped the 20,000-pound hatch cover from its welds and threw it 50 to 100 feet into the air and over the side of the ship.

The mill scale and the pig iron ingots were both contaminated with "rolling oil," which is a mixture of hydrocarbons used in mills to assist in the rolling process. On the basis of lab tests done after the explosion, the quantity of oil was estimated to be between a half pint and a quart per ton of mill scale. Also present with the mill scale were paper, wood, other organic debris, and water. At least some of the water got in when the concrete cap was poured; other possible sources are rain, condensation, and outdoor storage of the mill scale. In a sealed void, aerobic bacteria and oxidation (rust) will consume all of the available oxygen; then, under the right conditions of temperature, moisture, and acidity, colonies of anaerobic bacteria may develop and consume hydrocarbons (oils) and other organic debris. A byproduct of anaerobic bacteria is **methane,** which is only 60 percent as dense as air and eventually collects at the top of the void, even passing through the concrete cap. The production of methane and other combustible gases is very slow (think in terms of years), and almost any reasonably sized vent at the top of the void would help significantly, both by removing light gases and by admitting oxygen which would inhibit the activity of the anaerobic bacteria.

BE AWARE:

1. That unventilated enclosed spaces can be dangerous. Check them thoroughly from top to bottom (don't forget the heavy gases).

2. That solid ballast material can be contaminated and produce a hazardous atmosphere. Thorough cleaning is possible but may not be economically feasible.

3. That in an environment without air, organisms can live, consume organic materials, and produce methane (organic materials include wood, paper, cloth, oil, wax, paint, etc.). Methane is lighter than air and will collect at the top of a compartment.

4. That structural members in compartments can hold pockets of dangerous gases. Make allowance for this in ventilating the compartment and testing it for hazards.

5. That inadequate ventilation of a compartment containing an overrich fuel-air mixture can produce a flammable (this can mean explosive) environment instead of a safe one.

The preceding article was written by John A. Crawford of the Marine Safety Evaluation Branch. Anyone wanting more information about the explosion described above can contact him at: U.S. Coast Guard (G-MMI-3), Washington, DC 20593.

U.S. GOVERNMENT PRINTING OFFICE : 1981 O - 356-450